federal register

Friday
November 7, 1980

Part III

Department of Commerce

National Oceanic and Atmospheric Administration

Shrimp Fishery of the Gulf of Mexico; Plan Approval and Proposed Regulations

DEPARTMENT OF COMMERCE

National Oceanic and Atmospheric Administration

50 CFR Part 611 and 658

Shrimp Fishery of the Gulf of Mexico; Plan Approval and Proposed Regulations

AGENCY: National Oceanic and Atmospheric Administration (NOAA)/ Commerce.

ACTION: Approval of Fishery Management Plan, Proposed Regulations and request for comments.

SUMMARY: The Assistant Administrator for Fisheries, NOAA, has approved the fishery management plan for the shrimp fishery of the Gulf of Mexico (FMP), which was prepared by the Gulf of Mexico Fishery Management Council. The FMP governs the fisheries for six species of shrimp (brown, pink, white, royal red, seabobs and rock) which occur in the fishery conservation zone in the Gulf of Mexico. Regulations implementing the FMP are proposed. Comments on the FMP, the regulatory analysis, and the proposed regulations are invited.

DATE: Comments will be received until January 1, 1981.

ADDRESS: Please send comments to: Mr. Harold Allen, Acting Regional Director, Southeast Region, Duval Building, 9450 Koger Boulevard, St. Petersburg, Florida 33702.

FOR FURTHER INFORMATION CONTACT: Mr. Harold Allen (813) 896–3141.

SUPPLEMENTARY INFORMATION: The Fishery Conservation and Management Act of 1976, as amended, 16 U.S.C. 1801 *et seq.* (the "Act") authorizes the Secretary of Commerce (the "Secretary") to promulgate regulations implementing approved FMPs prepared by the Regional Fishery Management Councils for their geographic areas of concern. Pursuant to Title III of the Act, the Gulf of Mexico Fishery Management Council prepared and submitted to the Secretary an FMP for shrimp in the fishery conservation zone (FCZ) in the Gulf of Mexico.

A. Background

The Gulf shrimp fishery is the most valuable of all domestic commercial fisheries. From 1964 through 1977, shrimp averaged 23 percent of the total exvessel value of all fish landed in the United States. In 1977 shrimp accounted for $355.2 million of $1,515 million for all fish. From 1964 through 1977, Gulf shrimp comprised 83 percent of the total U.S. exvessel value of shrimp landings. The target species of the Gulf shrimp fishery are brown, white, pink, and royal red shrimp. Seabob and rock shrimp are taken incidentally to the target species.

The three most valuable species of shrimp (brown, white, and pink) are biologically impervious to the effects of intense fishing pressure because of the following factors:

1. The rapid growth rate of shrimp, under favorable conditions, results in sexual maturity within one year; and
2. The high fecundity of shrimp protects them from being depleted by overfishing.

There is not current evidence of overfishing of brown, white, or pink shrimp, because the rapid growth and high fecundity of these species offset current levels of natural and fishing mortality. The chief threat to the continuance of the major species of shrimp is loss of habitat, principally the estuarine environment. Continued mineral exploration, bulkheading, dredge and fill operations, channelization, and pollution could result in depletion of shrimp resources through the loss of productive estuarine nursery grounds. The other shrimp species (royal red, seabob, and rock shrimp) are not estuarine-dependent because they spend their entire life in the open waters of the Gulf. Royal red shrimp are found at depths of 100–300 fathoms in a relatively stable environment, and do not reach maturity in one year. Up to five year classes occupy the same fishing ground. Seabob are harvested with white shrimp in shallow water, primarily in the territorial sea off Louisiana. Rock shrimp are harvested with pink shrimp off Florida.

The Gulf States' regulations establish minimum legal sizes of shrimp that reflect the requirements of their respective industries. Louisiana, Mississippi, and Alabama have a size limit of 68 whole shrimp to the pound. Tremendous numbers of small shrimp are caught and landed in those States, which encourage use of small shrimp for canning and bait. Florida has a size limit of 47 whole shrimp to the pound (average of shrimp landed). The minimum Texas size limit is 39 whole shrimp to the pound. Small shrimp are culled from the catch and discarded from vessels' catches in Florida or Texas because of the States' size limits.

There are two general categories of vessels used in the Gulf shrimp fishery: (1) Small vessels from 16 to 50 feet that fish in State territorial waters and in sheltered inshore waters; and (2) larger, more mobile vessels more than 50 feet in length that may fish anywhere in the Gulf and are capable of remaining at sea for extended periods.

There is a live-bait shrimp fishery in shallow inshore waters which takes shrimp that are held live for sale as fish bait. Also, recreational shrimping is conducted from pleasure craft in shallow inshore waters. The shrimp are taken for personal use with small trawls and other nets.

B. The Management Regime

The Council, in preparing the FMP, identified problems in the shrimp fishery and proposed solutions which require both Federal regulation and State and Federal support. The primary problem addressed in the FMP is the harvest of shrimp well below optimal size and value. To optimize the yield of shrimp and the economic return to the fishermen, the FMP specifies an optimum yield (OY) for brown, pink, white, seabob, and rock shrimp. The specification of OY for shrimp presents a unique problem. Brown, pink, and white shrimp provide an annual crop because most are harvested when less than six months of age and very few live as long as 12 months. It is presently not possible to harvest so many shrimp that the survivors are unable to repopulate the fishery. A given year's yield is primarily dependent on temperature and salinity in the estuarine nursery areas. As a result, for the purpose of this FMP, OY for those three species and the associated rock and seabob is all the shrimp that can be taken each year during open seasons in open areas with existing gear and technology. The OY for the royal red shrimp is 177.8 metric tons (m.t.) (tails).

The U.S. capacity to harvest and process the shrimp resource meets or exceeds OY for all species except royal reds. A surplus of royal red shrimp of 66.2 mt is identified in the FMP and will be made available for foreign fishermen. No adverse impact on foreign fishermen is expected to result from implementation of the FMP.

If shrimp are harvested at a small size, the weight and value of the total landings may be reduced. If the shrimp are given additional time for growth before harvest, there will be a greater total yield in weight, even though the total number of shrimp will be less. The main purpose of the FMP is to encourage harvest of larger and more valuable shrimp through area closures.

The FMP establishes a permanent closure of an area off the State of Florida known as the "Tortugas Shrimp Sanctuary." The purpose is to protect small pink shrimp until most have reached a size larger than 69 shrimp tails to the pound. This measure re-

establishes in the FCZ a shrimp conservation area formerly maintained by the State of Florida. The State presently prohibits all shrimp trawling by Florida vessels, except for live-bait fishing, within the proposed sanctuary.

Establishment of a closure of the FCZ off the State of Texas for a 45-day period (normally June 1 through July 15) to protect small brown shrimp is also proposed. This controversial closure, which is a "trial measure," is expected to benefit the shrimp industry.

A seasonal closure of the entire FCZ in the Gulf was not selected because of possible adverse impacts on the Louisiana canning industry that depends on a continuing supply of smaller shrimp from the FCZ during the proposed period of closure. When brown shrimp reach the FCZ off Mississippi and Alabama they are of a larger and more economically desirable size.

The State of Texas traditionally closes its nine-nautical-mile territorial sea to shrimp fishing for a 45-day period, during which brown shrimp generally are less than the size of 39 whole shrimp to the pound. The purpose is to allow for further growth that will increase the weight and value of the harvest when the area is opened. The dates of the closure may be adjusted up to 15 days on either end, but the closure may not exceed 60 days, nor be less than 45 days.

The State measure has not been completely effective because small shrimp move beyond State jurisdiction into the FCZ and because many shrimp vessels are alleged to enter the territorial sea at night when most brown shrimp fishing occurs. Many small shrimp are taken which, because of the Texas size limit, cannot be landed in Texas and are culled from the catch and discarded. While the State closure is in effect, some Texas vessels tie up, others continue to fish in the FCZ off Texas (and allegedly in the territorial sea), and others shift effort to the Louisiana coast or elsewhere.

The FMP indicates that the proposed cooperative Texas closure will result in an increase in exvessel value of $7.1 million (increased growth and use of previously discarded shrimp). However, the Council recognizes that the seasonal closure could result in displacement and shift of effort in the shrimp fleet. For example, Louisiana shrimp fishermen may fish in the FCZ off Texas after the closure terminates and thus share in the benefits.

Six Council members filed two minority reports stating their opposition to the Texas closure. The statements cite the importance of Texas' eliminating its size limitation and the possible adverse impact of the closure on Louisiana shrimp fishermen. The Louisiana shrimp fishermen protested that, if the closure of the FCZ off Texas is implemented, more vessels will move to the Louisiana coast during the 45-day period.

Because of the concern about the potential impact on Louisiana fishermen, the Council will evaluate further the effect of the Texas closure on fishermen from all States and consider whether any alternatives, such as extending the area of the FCZ closure, would prevent undue adverse impact. A baseline study comparing the 1980 season (closure of Texas waters only) and the 1981 season cooperative closure of both FCZ and Texas waters) will assist the Council in this evaluation. The FMP could be amended, as appropriate, prior to the 1982 fishing season.

The FMP incorprates the seasonal closure of a portion of the Tortugas shrimp grounds to avoid gear conflict with stone crab fishermen. This measure was implemented under the stone crab fishery management plan, (44 FR 18031) and has been effective in preventing damage to stone crab gear and in increasing the size and value of shrimp harvested outside the line.

To encourage harvest of optimal-size shrimp, the FMP also encourages establishment of State sanctuaries in nursery grounds inside the territorial sea and elimination of State restrictions on landing of small shrimp.

The Council recommends that the Gulf States adopt flexible management procedures to regulate shrimp fisheries in the internal waters and territorial sea by State administrative agencies, rather than by direct State legislative actions. The FMP also urges the States to adopt procedures to allow joint management of shrimp fisheries with other States and NMFS.

All the sea turtles of the Gulf of Mexico are threatened or endangered and need protection. Sea turtles are caught incidentally in the trawls of shrimp fishermen. The catch of sea turtles in shrimp trawls results in some level of mortality. The implementation of closures recommended by the FMP will have direct and coincidental benefits for sea turtles by reducing the level of mortality. Two of the recommendations adopted by the Council are specifically aimed at sea turtle conservation: the encouragement of research and development of trawl gear that excludes turtles; and the recommendation to develop and implement an education program for fishermen regarding sea turtles.

A consultation was held in accordance with Section 7 of the Endangered Species Act to determine whether implementation of the FMP would be likely to jeopardize the continued existence of any endangered or threatened species or to result in the destruction or adverse modification of critical habitat of such species. It has been determined that the actions to be implemented through the FMP are not likely to jeopardize the continued existence of any listed species or adversely affect their habitat. The NMFS Southeast Region has a Sea Turtle program designed to conserve sea turtles in accordance with the Endangered Species Act. In addition to projects concerning turtle biology and habitat, the program involves: (1) monitoring the incidental catch and mortality of sea turtles from commercial shrimp vessels; and (2) developing gear moification to exclude turtles from shrimp trawls. A recovery team has been formed to prepare a sea turtle recovery plan. NMFS believes its Sea Turtle Program is a more appropriate vehicle than the Shrimp FMP to address the problem of the incidental catch of sea turtles in all trawl fisheries.

The FMP encourages research on, and development of, finfish gear that would reduce the incidental catch of finfish without decreasing the overall efficiency of shrimping or imposing an excessive cost for such modified gear.

The Council has established a committee to monitor and review the proposed construction of artifical offshore reefs. The committee intends also to meet with representatives of the oil and gas industries in order to minimize the capping of well-heads above the sea floor.

C. Measures of Major Impact

Better information is needed for effective management of the Nation's most valable fishery. Because of the complex and diverse nature of the commercial and recreational shrimp fisheries, the cost of obtaining specific biological, environmental, social, and economic information from each user would be prohibitively high. Therefore, the FMP recommends that NMFS develop a system whereby sampling methods will be used whenever a sample will be representative and will provide information of adequate precision. The Center Director will determine the number of shrimp fishermen who will be required to keep records and to report based on the data required for specific management needs. When only a portion of such individuals are needed to provide information, the Center Director will select those individuals through use of standard statistical sampling procedures.

The NMFS will design, test, evaluate, and implement procedures for collecting all information on individual fishing trips required from shrimp dealers on receipts at the time of sale. The procedures proposed in the regulations would require all shrimp dealers and processores to keep records and report but would require only those shrimp fishermen specifically selected by the Center Director to keep records and report. However, current methods of data collection based on port agent contact with dealers and fishermen will be used prior to implementation of the sales receipt system described in the regulations.

The area of the Texas closure, depicted in Figure 3 of the regulations, encompasses the FCZ off Texas between the territorial sea and the outer boundary of the FCZ. It is bounded by extensions of the boundary lines separating Texas from Louisiana and Mexico. Although the dates of the closure are June 1 to July 15, under the criteria listed below, the NMFS Regional Director may adjust the closing or opening date by as much as 15 days to provide for an earlier, later, or longer closure. However, the closure may not exceed 60 days, nor be less than 45 days. The criteria upon which the Regional Director must base an adjustment of the closing or opening date are: (1) Biological data collected by the Texas Parks and Wildlife Commission (TPWC) used to predict when brown shrimp in the central northern bays of Texas will reach a total length of 80 to 90 mm; (2) the strength of outgoing tides at the time predicted under (1); and (3) other biological data relevant to the timing or duration of the closure.

Although no permit is rquired for vessels of the United States fishing for shrimp in the FCZ, a letter of authorization is required for those United States vessels fishing for royal red shrimp beyond 100 fathoms in the FCZ off of Texas during the period of the Texas closure. Application is made to the Regional Director of NMFS, who will issue such letters of authorization by May 1.

The boundary line separating the geographical areas of the Gulf of Mexico and South Atlantic Fishery Management Councils (Councils) has been the subject of controversy. In a legal opinion to NOAA, the Department of Justice stated that the boundary line should be based only upon geographical factors. In response to that opinion, NOAA has proposed that the geographical boundary line accepted by the United States Supreme Court in *U.S.* v. *Florida* separate the areas of authority of the Councils.

The shrimp regulations apply only in the Gulf of Mexico Council's area of authority. Therefore the line delineating the Tortugas closure area in the regulations is different from the one described in the FMP, which extends into the South Atlantic Council's ara. If the boundary line separating the areas of authority of the Councils is changed in the final rulemaking on that issue, then the area of coverage of these regulations also would be changed.

Subpart D of 50 CFR Part 611 has been amended to incorporate all regulations, including those for royal red shrimp, governing foreign fishing in the FCZ in the Caribbean Sea, Gulf of Mexico, and the Atlantic Ocean south of 35°00′ N. latitude. Only §§ 611.60, 611.61, and 611.62 are affected. No changes have been made to those sections other than a restructuring to provide for the inclusion of shrimp. Those proposed sections are reprinted in their entirety in this document.

The adoption and implementation of the FMP is a major Federal action that will have a significant impact on the quality of the human environment. Pursuant to the National Environmental Policy Act and NOAA Directive 02–10, a draft environmental impact statement was filed with the Environmental Protection Agency. The notice of availability was published in the **Federal Register** on November 6, 1979 (44 FR 64114). The final environmental impact statement is being prepared and will soon be filed.

The Assistant Administrator for Fisheries, NOAA, has determined that this is a significant action under Executive Order 12044, and a regulatory analysis has been prepared. A copy of the draft regulatory analysis may be obtained by writing to: Mr. Harold Allen, Acting Regional Director, Southeast Region, National Marine Fisheries Service, 9450 Koger Boulevard, St. Petersburg, Florida 33702. The regulations and the FMP are set forth below.

Signed in Washington, D.C. this 22d day of October 1980.

(16 U.S.C. 1801 *et seq.*)

Robert K. Crowell,

Deputy Executive Director, National Marine Fisheries Service.

PART 611—FOREIGN FISHING

A. It is proposed to amend 50 CFR Part 611 as follows:

Subpart D is amended by the addition of §§ 611.60, 611.61 and 611.62 as follows:

Subpart D—Atlantic, Caribbean, and Gulf of Mexico

* * * * *

§ 611.60 General Provisions.

(a) *Purpose.* This subpart regulates:

(1) All foreign fishing conducted under a Governing International Fishery Agreement (GIFA) within the fishery conservation zone (FCZ) in the Atlantic Ocean south of 35°00′N. latitude, in the Gulf of Mexico, and in the Caribbean Sea; and

(2) All foreign longline fishing conducted under a GIFA which involves the catching of any species of billfishes, sharks, or other fish in the FCZ in the Atlantic Ocean, Gulf of Mexico, and Caribbean Sea.

(b) *Authorized fishery*—(1) *Allocations.* Foreign vessels may engage in fishing only in accordance with applicable allocations.

(2) *TALFF.* The TALFFs are set forth in Appendix 1 to § 611.20

(3) *Permitted fishing.* Foreign fishing authorized under this subpart may be conducted only during the seasons, in the open areas, and with the gear specified in §§ 611.61 and 611.62

(c) *Prohibited species.* (1) All species of fish over which the United States exercises exclusive fishery management authority and for which there is no applicable allocation are prohibited species and shall be treated in accordance with § 611.13. Fish caught in excess of an applicable national allocation are prohibited species.

(2) As a means of rebutting the presumption of § 611.13(c), a vessel may store all prohibited species caught outside the FCZ in a separate part of the hold that can be sealed, and may have its holds inspected and sealed before commencing fishing in the FCZ. Seals affixed during such inspection shall be maintained in an unbroken condition during the time the fishing vessel is in the FCZ. Such inspections may be obtained at Venice or New Orleans, La., Key West, Fla., Mayaquez, P.R., or Norfolk, Va., upon 48 hours advance notification to: Regional Director, Southeast Region, National Marine Fisheries Service, Duval Building, 9430 Koger Boulevard, St. Petersburg, Fla. 33702. Telephone: (813) 893–3145.

(3) Additional ports for hold inspection may be arranged with the Regional Director.

(4) The designation of ports for hold inspections does not modify the port entry arrangements or requirements (if any) of Governing International Fishery Agreements or the notification requirements of any other laws or regulations of the United States.

(d) *Open area.* Except for the closed area set forth in paragraph (e) of this section, foreign fishing authorized under this subpart may be conducted in that portion of the FCZ in the Atlantic Ocean, Gulf of Mexico, and Caribbean Sea beyond 12 nautical miles from the baseline used to measure the U.S. territorial sea.

(e) *Closed area.* The area known as East and West Flower Garden Banks is closed to directed foreign fishing. Flower Garden Banks is the Ocean space including the water column and the surface waters within two intersecting circles 9 nautical miles in radius from the center of each bank. The area of this proposed national marine sanctuary is 432 square nautical miles. The geographical centers of the banks are as follows: for the West Flower Garden Bank, the center point, P2, is located at 27°52' 14.21"N. lat., 93°48'54.79"W. long.; and for the East Flower Garden Bank, the center point is located at 27°55'07.44"N. lat., 93°36'08.49"W. long.

§ 611.61 Atlantic billfish and sharks fishery.

(a) *Purpose.* This section regulates all foreign fishing conducted pursuant to a GIFA which involves the catching of any species of billfishes, sharks, or other fish in the FCZ in the Atlantic Ocean, Gulf of Mexico, or Caribbean Sea.

(b) *Open season and closures.* Foreign fishing under this section may be conducted throughout the year, except that any retention of sharks shall terminate when the applicable national allocation has been reached. The closure provisions of § 611.15(a) do not apply to this section.

(c) *Prohibited species.* Unless otherwise specifically instructed by a U.S. observer or Authorized Officer, all billfish and all prohibited sharks must be released by cutting the line (or by other appropriate means) without removing the fish from the water.

(d) *Gear restrictions.* Foreign vessels participating in a directed fishery for sharks must use a minimum sized hook of 7 inches shank length and 2.5 inches gap (distance between tip and shank) when fishing inside the 100-fathom depth contour. There is no hook size restriction seaward of the 100-fathom depth contour.

(e) *Statistical reporting.* (1) In addition to the requirements of § 611.9, a vessel of a nation with an applicable allocation shall submit the following additional quarterly reports:

(i) Catch and effort data, summarized weekly by one degree squares, containing the following information:

(A) Number of hooks set,

(B) Number of sharks caught under allocation,

(C) Number of prohibited species (by species code from Appendix I to § 611.9) caught and released,

(D) Number of prohibited species (by species code) released alive.

(ii) Summary of vessel activities containing the following information:

(A) Permit number of each vessel fishing,

(B) For each successive day of the reporting period, the noon-day location (within 0.1 degree of latitude and longitude) of each vessel in the fishery.

(2) A vessel of a nation with no applicable allocation is exempt from the requirements of § 611.9(d) and (e), but shall provide the reports required by § 611.9(f) and (g), when applicable. In addition, a vessel of a nation with no applicable allocation shall submit the quarterly reports described in paragraph (e)(1)(i)(A), (C), and (D), only, and (ii) of this section.

(3) The quarterly reports required by paragraphs (e)(1) and (2) of this section shall be submitted, not later than 60 days from the end of the quarter for which the report is being made, to: Director, Southeast Fisheries Center, National Marine Fisheries Service, 75 Virginia Beach Drive, Miami, Florida 33149. Telephone: (305) 361–5761.

§ 611.62 Royal red shrimp fishery.

(a) *Purpose.* This section regulates all foreign fishing conducted pursuant to a GIFA which involves the catching of royal red shrimp in the FCZ of the Gulf of Mexico.

(b) *Closed areas.* Fishing by foreign vessels for royal red shrimp is prohibited in depths less than 100 fathoms.

(c) *Gear restrictions.* No foreign vessel may use gear other than trawl gear to fish for royal red shrimp, except as specifically authorized in writing by the Regional Director.

Appendices to §§ 611.9 and 611.20

1. Amend Appendix 1 to § 611.9, Atlantic Ocean Fishes, Invertebrates, by adding a new Code 630—Royal Red Shrimp, as follows:

Appendix I—Species Codes

A. Atlantic Ocean Fishes (Including the Gulf of Mexico)

Code	Common English name	Scientific name
	* * * * *	
	Invertebrates	
	* * * * *	
630	Shrimp, royal red	*Hymenopenaeus robustus*

2. Amend Appendix I to § 611.20 by adding the following B. to 2. Atlantic and Gulf Fisheries:

Appendix I.—*OY, DAH, JVP, TALFF*

Species	Species code	Areas	OY optimum yield (mt)	Domestic allowable harvest (DAH) (mt)	Est. joint venture processing capacity (JVP) (mt)	Reserve	TALFF
* *	*	*	*	*	*		*
2. Atlantic and Gulf Fisheries:							
* *	*	*	*	*	*		*
B. Royal red Shrimp fishery	630		177.8	111.6			66.2
* *	*	*	*	*	*		*

B. It is proposed to add a new 50 CFR Part 658 as follows:

PART 658—GULF SHRIMP FISHERY

Subpart A—General Measures

Sec.

658.1 Purpose and scope.
658.2 Definitions.
658.3 Relation to other laws.
658.4 Vessels, permits, and fees.
658.5 Recordkeeping and reporting.
658.6 Vessel identification.
658.7 Prohibitions.
658.8 Enforcement.
658.9 Penalties.

Subpart B—Management Measures

Sec.

658.20 Fishing year.
658.21 Allowable levels of harvest.
658.22 Tortugas Shrimp Sanctuary.
658.23 Stone crab closure.
658.24 Texas closure.
658.25 Size restrictions.

Authority: 16 U.S.C. 1801 et seq.

Subpart A—General Measures

§ 658.1 Purpose and scope

(a) The purpose of this part is to implement the Fishery Management Plan for the Shrimp Fishery of the Gulf of Mexico, U.S. Waters, developed by the Gulf of Mexico Fishery Management Council pursuant to the Fishery Conservation and Management Act of 1976, as amended.

(b) The regulations in this Part govern fishing for brown shrimp, white shrimp, pink shrimp, royal red shrimp, seabobs, and rock shrimp by vessels of the United States within that portion of the Gulf of Mexico over which the United States exercises exclusive fishery management authority.

(c) Regulations governing foreign fishing for royal red shrimp appear in 50 CFR Part 611. Appendix I to § 611.20 contains the TALFF for royal red shrimp.

§ 658.2 Definitions

In addition to the definitions in the Act, the terms used in this Part shall have the following meanings:

Act means the Fishery Conservation and Management Act of 1976, as amended (16 U.S.C. 1801 *et seq.*).

Assistant Administrator means the Assistant Administrator for Fisheries, National Oceanic and Atmospheric Administration, Department of Commerce, or an individual to whom appropriate authority has been delegated.

Authorized Officer means:

(a) Any commissioned, warrant, or petty officer of the U.S. Coast Guard;

(b) Any certified enforcement officer or special agent of the National Marine Fisheries Service;

(c) Any officer designated by the head of any Federal or State agency which has entered into an agreement with the Secretary and the Commandant of the Coast Guard to enforce the provisions of the Act; or

(d) Any U.S. Coast Guard personnel accompanying and acting under the direction of any person described in paragraph (a) of this definition.

Center Director means the Center Director, Southeast Fisheries Center, National Marine Fisheries Service, 75 Virginia Beach Drive, Miami, Florida 33149. Telephone (305) 361–5761.

Catch, take, or harvest includes, but it not limited to, any activity which results in bringing any shrimp on board a vessel.

Fishery Conservation Zone (FCZ) means that area adjacent to the territorial sea of the constituent States of the United States which, except where modified to accommodate international boundaries, encompasses all waters from the seaward boundary of each of the coastal States to a line on which each point is 200 nautical miles from the baseline from which the territorial sea of the United States is measured.

Fishery Management Plan (FMP) means the Fishery Management Plan for the Shrimp Fishery of the Gulf of Mexico, U.S. Waters, and any amendments thereto.

Fishing means any activity, other than scientific research conducted by a scientific research vessel, which involves:

(a) The catching, taking, or harvesting of shrimp;

(b) The attempted catching, taking, or harvesting of shrimp;

(c) Any other activity which can reasonably be expected to result in the catching, taking, or harvesting of shrimp;

(d) Any operations at sea in support of, or in preparation for, any activity described in paragraph (a), (b), or (c) of this definition.

Fishing vessel means any vessel, boat, ship, or other craft which is used for, equipped to be used for, or of a type which is normally used for:

(a) Fishing; or

(b) Aiding or assisting one or more vessels at sea in the performance of any activity relating to fishing, including, but not limited to, preparation, supply, storage, refrigeration, transportation, or processing.

Gulf of Mexico means geographic area of authority of the Gulf of Mexico Fishery Management Council.

Operator, with respect to any vessel, means the master or other individual on board and in charge of that vessel.

Owner, with respect to any vessel, means:

(a) Any person who owns that vessel in whole or in part;

(b) Any charterer of that vessel, whether bareboat, time, or voyage;

(c) Any person who acts in the capacity of a charterer, including, but not limited to, parties to a management agreement, operating agreement, or other similar arrangement that bestows control over the destination, function, or operation of the vessel; or

(d) Any agent designated as such by any person described in paragraph (a), (b), or (c) of this definition.

Person means any individual (whether or not a citizen or national of the Untied States), corporation, partnership, association, or other entity (whether or not organized or existing under the laws of any State), and any Federal, State, local, or foreign government, or any entity of any such government.

Regional Director means the Regional Director, Southeast Region, Duval Building, 9450 Koger Boulevard, St. Petersburg, Florida 33702, or a designee.

Shrimp means the following species:

Brown shrimp, *Penaeus aztecus*
White shrimp, *P. setiferus*
Pink shrimp, *P. duorarum*
Seabobs, *Xiphopeneus koyeri*
Rock shrimp, *Sicyonia brevirostris*
Royal red shrimp, *Hymenopenaeus robustus United States harvested shrimp* means shrimp caught, taken, or harvested by vessels of the United States under this Part, whether or not such shrimp is landed in the United States.

Vessel of the United States means:

(a) A vessel documented or numbered by the U.S. Coast Guard under United States law; or

(b) Any vessel under five net tons registered under the laws of any State.

§ 658.3 Relation to other laws.

(a) Persons affected by these regulations should be aware that other Federal and State statutes and regulations may apply to their activities.

(b) The regulations found in this Part are intended to be compatible with regulations pertaining to the Everglades National Park in the State of Florida. These regulations are found at 36 CFR 7.45 and 36 CFR 7.27.

(c) Certain responsibilities relating to data collection and enforcement may be performed by authorized State personnel in accordance with a cooperative agreement entered into by the State, the U.S. Coast Guard, and the Secretary.

§ 658.4 Vessel permits and fees.

(a) *General.* No permit is required for vessels of the United States fishing for shrimp under this Part.

(b) *Royal red shrimpers.* During the Texas closure, a vessel may fish for royal red shrimp beyond the 100-fathom curve in the area described in § 658.24(a), if the vessel has on board a letter of authorization signed by the Regional Director.

(c) *Application for letter of authorization.* (1) By April 1, the owner or operator of a vessel intending to fish for royal red shrimp during the Texas closure shall submit a letter to the Regional Director stating such intent and including the following information:

(i) The name, mailing address, including ZIP code, and telephone number of the owner of the vessel;

(ii) The name of the vessel; and

(iii) The vessel's U.S. Coast Guard documentation number or the vessel's State registration number for vessels not

required to be documented under Title 46 of the U.S. Code.

(d) *Issuance of letter of authorization.* By May 1, the Regional Director will issue letters of authorization to applicants under paragraph (c) of this section.

§ 658.5 Recordkeeping and reporting.

(a) *Owners and operators.* The owner or operator of any fishing vessel or boat engaged in fishing for shrimp shall report to the National Marine Fisheries Service (NMFS) the information required by this section.

(1) *Selection.* The Center Director will use statistical sampling procedures to select all or a portion of shrimp fishermen to report information. The number of individuals selected, the reporting interval, and the duration for reporting will be determined by the Center Director according to data requirements for specific management needs. The NMFS may conduct surveys to obtain information on recreational shrimp fishing and to assess the accuracy and precision of any data collected under this section.

(2) *Information.* When notified by agents authorized by NMFS of his/her selection for reporting, the owner or operator of a shrimp vessel shall provide the information requested on a form available from the dealer at the time of sale. The information may include any of the following items:

(i) Vessel identification, including official number.

(ii) Date landed.

(iii) Days fished.

(iv) Area and depth of catch.

(v) Fishing time by species, area, and depth.

(vi) Gear type, number, and quantity.

(vii) Kinds and quantities of incidental catch and discards.

(viii) Other biological, social, and economic information.

(b) *Dealers.* Shrimp dealers shall provide the following information on individual fishing trips on forms provided by NMFS:

(1) Dealer or plant identification number.

(2) Official number.

(3) Date landed.

(4) Shrimp landed in pounds and value by species and class.

(5) Other social and economic information.

(c) *Processors.* Shrimp processors shall provide the following information on forms provided by NMFS:

(1) Processor identification.

(2) Type of product(s).

(3) Shrimp processed (quantity and value by product).

(4) Number of employees.

(5) Other social and economic information.

(d) *Filing.* Reports under this section shall be recorded on a form provided by the Center Director, or as otherwise described in this paragraph, as follows:

(1) Owners/operators of fishing vessels/boats—Required information shall be recorded at the time of the sale on a form provided by NMFS.

(2) Dealers—Copies of forms required to be submitted containing the required information shall be forwarded to NMFS within three days of the close of a business week.

(3) Processors—Required information shall be submitted on a form and at times specified by the Center Director.

§ 658.6 Vessel identification.

(a) *Offical number.* Each vessel of the United States engaged in the shrimp fishery in the Gulf of Mexico FCZ shall:

(1) Display its official number on the port and starboard sides of the deckhouse or hull and on an appropriate weather deck so as to be clearly visible from enforcement vessels and aircraft. The official number is the documentation number issued by the Coast Guard for documented vessels, or the registration number issued by a State or the Coast Guard for undocumented vessels.

(2) The official number must be in block arabic numerals in contrasting color to the background.

(3) The official number shall be at least 18 inches in height for fishing vessels over 65 feet in length and at least 10 inches in height for all other vessels.

(4) The official number shall be permanently affixed to or painted on the vessel.

(b) *Duties of operator.* The operator of each fishing vessel shall:

(1) Keep the name or registration number clearly legible and in good repair, and

(2) Insure that no part of the fishing vessel, its rigging, or its fishing gear obstructs the view of the official number from any enforcement vessel or aircraft.

§ 658.7 Prohibitions.

It is unlawful for any person to:

(a) Possess, have custody or control of, ship, transport, offer for sale, sell, purchase, import, land, or export any shrimp taken or retained in violation of the Act, this Part, or of any other regulation promulgated under the Act;

(b) Fish for shrimp in a closed area or during a closed season within the FCZ, except as allowed under § 658.4(b);

(c) Transfer directly or indirectly, or attempt to so transfer, any United States harvested shrimp to any foreign fishing vessel, while such vessel is within the FCZ, unless the foreign fishing vessel has been issued a permit under section 204 of the Act which authorizes the receipt by such vessel of United States harvested shrimp;

(d) Falsify or fail to affix and maintain vessel markings as required by § 658.6;

(e) Falsify or fail to make, keep, maintain, or submit any record or report required by § 658.5;

(f) Refuse to permit an Authorized Officer to board a fishing vessel subject to such person's control for purposes of conducting any search or inspection in connection with the enforcement of the Act, this Part, or any other regulation issued under the Act;

(g) Refuse to permit an Authorized Officer to inspect any record required to be kept under § 658.5;

(h) Fail to comply immediately with enforcement and boarding procedures specified in § 658.8;

(i) Forcibly assault, resist, oppose, impede, intimidate, threaten, or interfere with any Authorized Officer in the conduct of any search or inspection under the Act;

(j) Resist a lawful arrest for any act prohibited by this part;

(k) Interfere with, delay, or prevent by any means the apprehension or arrest of another person, knowing that such other person has committed any act prohibited by this part;

(l) Interfere with, obstruct, delay or prevent by any means a lawful investigation or search in the process of enforcing this part;

(m) Interfere with, obstruct, delay, or in any other manner prevent the seizure of illegally taken shrimp or the final disposition of such shrimp through the sale of the shrimp; or

(n) Violate any other provision of this part, the Act, or any regulation promulgated pursuant thereto.

§ 658.8 Enforcement.

(a) *General.* The owner or operator of any fishing vessel subject to this part shall immediately comply with instructions issued by an Authorized officer to facilitate safe boarding and inspection of the vessel, its gear, equipment, and catch for purposes of enforcing the Act and this part.

(b) *Signals.* Upon being approached by a U.S. Coast Guard vessel or aircraft, or any other vessel or aircraft authorized to enforce provisions of the Act, the operator of a fishing vessel shall be alert for communications conveying enforcement instructions. The VHF–FM radiotelphone is the normal method of communicating between vessels. Should radiotelphone communications fail, however, other

methods of communicating between vessels, including visual signals, may be employed. The following signals extracted from the International Code of signals are among those which may be used, and are included here for the safety and information of fishing vessel operators:

(1) "L" meaning "You should stop your vessel instantly."

(2) "SQ3" meaning "You should stop or heave to; I am going to board you."

(3) "AA AA AA etc." which is the call to an unknown station, to which the signaled vessel should respond by illuminating the name or number required by § 658.6, and

(4) "RYCY" meaning "You should proceed at slow speed, a boat is coming to you."

(c) *Boarding.* A vessel signaled to stop or heave to for boarding shall:

(1) Guard Channel 16, VHF–FM, if so equipped;

(2) Stop immediately and lay to or maneuver in such a way as to permit the Authorized Officer and his party to come aboard;

(3) Provide a safe ladder, if required, for the Authorized Officer and his party;

(4) When necessary to facilitate the boarding and/or when requested by an Authorized Officer, provide a man rope or safety line; and

(5) Take such other actions as necessary to ensure the safety of the Authorized Officer and his party to facilitate the boarding.

§ 658.9 Penalties

Any person or fishing vessel found to be in violation of this Part is subject to the civil and criminal penalty provisions and forfeiture provisions prescribed in the Act, and to 50 CFR Parts 620 (Citations) and 621 (Civil Procedures).

Subpart B—Management Measures

§ 658.20 Fishing year

The fishing year for all species of shrimp, except royal red shrimp, begins on May 1 and ends on April 30. The fishing year for royal red shrimp begins January 1 and ends December 31.

§ 658.21 Allowable levels of harvest

(a) *Catch quotas.* The domestic quota for royal red shrimp is 111.6 metric tons. There is no domestic quota for other species of shrimp.

(b) *Territorial waters.* These regulations do not limit the harvest of shrimp resources in waters landward of the FCZ. However, harvest from these waters will be taken into account in the calculation of the maximum sustainable yield and optimum yield from the fishery.

(c) *Closure.* When the domestic quota for royal red shrimp is reached, the Regional Director shall close the fishery by publishing a notice in the Federal Register

§ 658.22 Tortugas shrimp sanctuary

The area commonly known as the "Tortugas Shrimp Sanctuary," off the State of Florida, is closed to all fishing for shrimp. The area is that part of the fishery conservation zone shoreward of the following line (see Figure 1):

Begin at the intersection of the Florida territorial sea with a line drawn between point N (Coon Key Light, 25°52.9′ N. lat., 81°37.95′ W. long.) and point F (24°50.7′ N. lat., 81°51.3′ W. long.); thence proceed on a straight line to point F; thence proceed on a straight line to point G (New Grounds Shoals Light, 24°40.1′ N. lat., 82°26.7′ W. long.); thence proceed on a straight line to point H (Rebecca Shoals Light, 24°34.7′ N. lat., 82°35.1′ W. long.); thence proceed on a straight line to the intersection of the Florida territorial sea with a line drawn from point H to point P (Marquesas Keys, approximately 24°35′ N. lat., 82°08′ W. long.).

BILLING CODE 3510–22–M

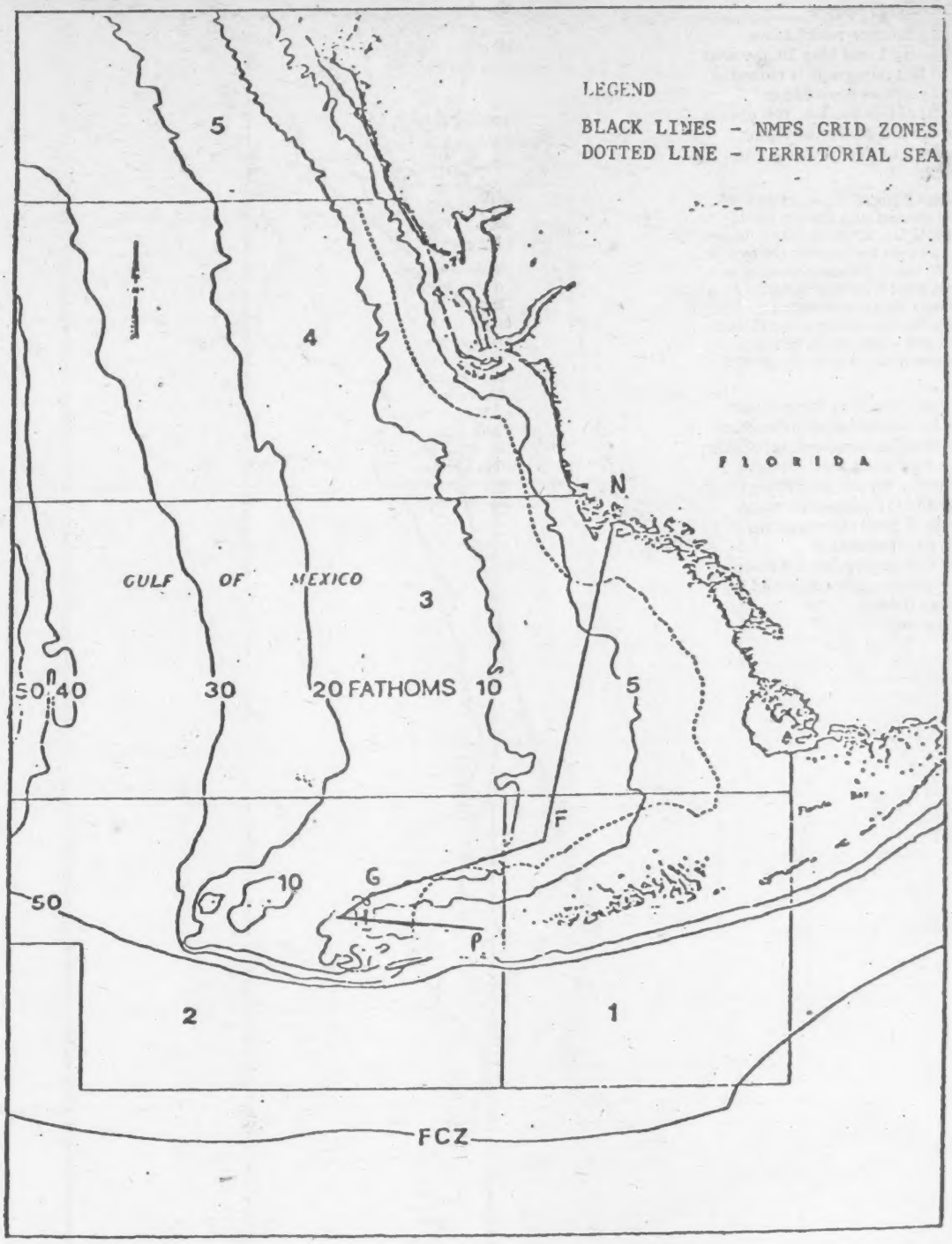


FIGURE 1. LOCATION OF PROPOSED TORTUGAS SHRIMP SANCTUARY.

BILLING CODE 3510—22—C

§ 658.23 Stone crab closure

(a) *Area and season restrictions.* Between January 1 and May 20, the area described in this paragraph is closed to trawl gear, except as provided in paragraph (b) of this section. The area is that part of the fishery conservation zone shoreward of the following line (see Figure 2):

Begin at point B (26°16′ N. lat., 81°58.5′ W. long.); thence proceed on a straight line to point C (26°00′ N. lat., 82°04′ W. long.); thence proceed on a straight line to point D (25°09′ N. lat., 81°47.6′ W. long.); thence proceed on a straight line to point E (24°54.5′ N. lat., 81°50.5′ W. long.); thence proceed on a straight line to the intersection of the Florida territorial sea with a line drawn between point E and point M (24°41.9′ N. lat., 81°40.5′ W. long.).

(b) *Exception.* Trawling for live bait shrimp may be conducted shoreward of the line specified in paragraph (a) of this section. Live bait boats must (1) have live shrimp wells, (2) use gear other than otter trawls, and (3) possess no more than 5 pounds of dead shrimp at any time. It shall be a rebuttable presumption that any vessel not meeting all the above criteria is not engaged in the bait shrimp fishery.

BILLING CODE 3510-22M

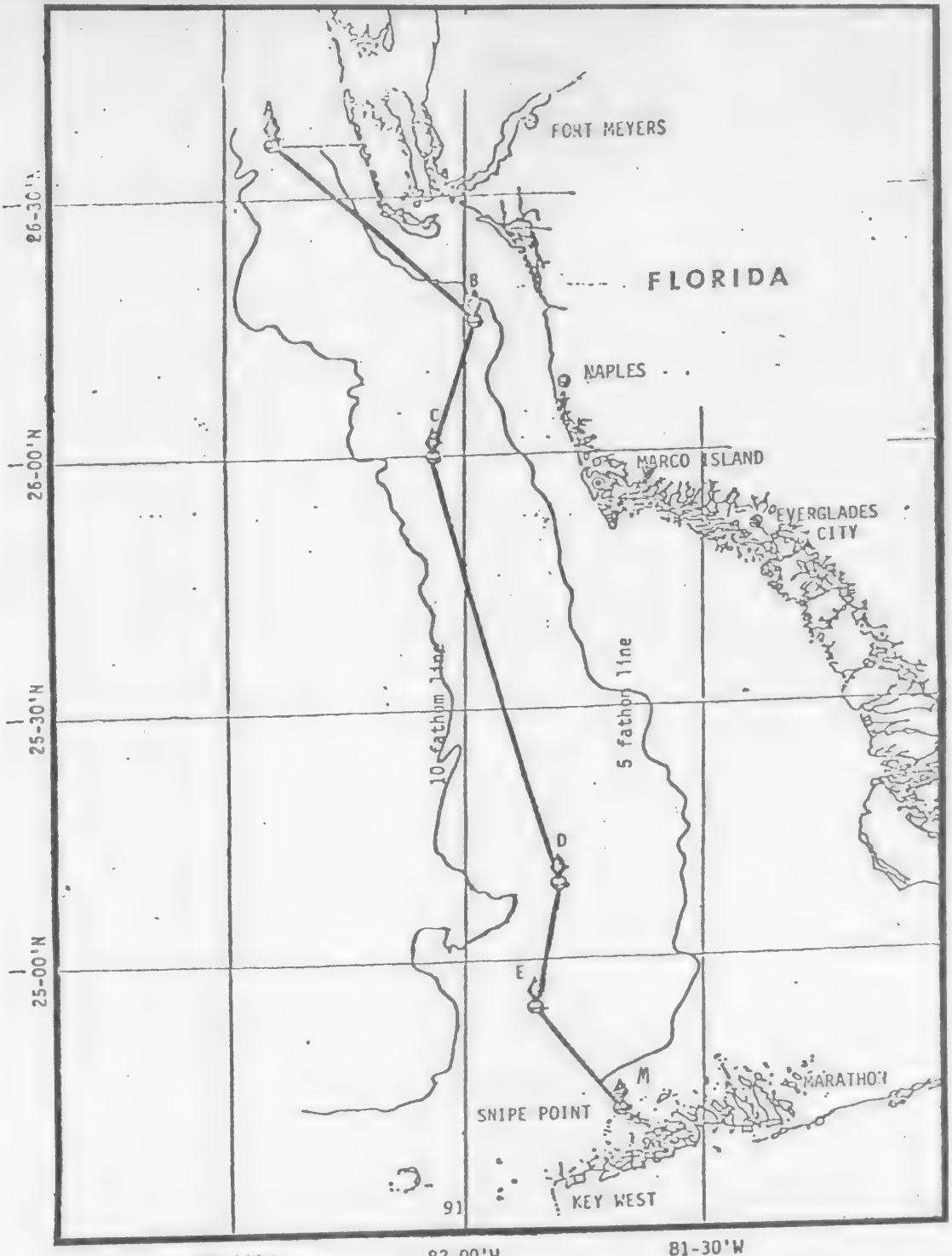


FIGURE 2. AREA CLOSED TO SHRIMPING BETWEEN JANUARY 1 AND MAY 20.

BILLING CODE 3510-22-C

§ 658.24 Texas closure.

(a) *Area and season restrictions.* Between June 1 and July 15, the area described in this paragraph is closed to all fishing for shrimp, except as permitted in § 658.4(b) for royal red shrimp. The area is that part of the fishery conservation zone off the State of Texas west of a line beginning at point A (29°32.1′ N lat., 93°47.7′ W long.) and proceeding directly to point B (26°11.4′ N lat., 92°53′ W long.) (see Figure 3).

(b) *Adjustment of dates.* The Regional Director may adjust the closing or opening date by as much as 15 days, to provide an earlier, later, or longer closure; but the duration of the closure may not exceed 60 days, nor be less than 45 days.

(1) The Regional Director must base an adjustment of the closing or opening date on the following criteria:

(i) Biological data collected by the Texas Parks and Wildlife Commission (TPWC) and used to predict when brown shrimp in the central and northern bays of Texas will reach a total length of 80 to 90 mm;

(ii) The strength of outgoing tides at the time predicted under paragraph (b)(1)(i) of this section; and

(iii) Other biological data relevant to the timing or duration of the closure.

(2) The Regional Director, after consulting with the TPWC, may adjust the closing or opening date by issuing a field order. The order will specify the adjusted date and the reasons for the adjustment.

(3) A field order advancing the closing date or delaying the opening date must have been available to the public for 72 hours before its effective date. A field order delaying the closing date or advancing the opening date must have been available to the public for 24 hours before its effective date.

(4) A field order may be made available to the public by any of the following methods:

(i) Procedures customarily used by the TPWC for posting and publicizing similar notices of opening or closure;

(ii) Publication of a notice in a newspaper of major circulation in each of the following cities: Brownsville, TX; Aransas Pass, TX; Galveston, TX; Corpus Christi, TX; Freeport, TX; Port Arthur, TX; Cameron, LA; and Morgan City, LA;

(iii) Notification of shrimp fishery organizations in all the States bordering the Gulf of Mexico;

(iv) Broadcast of a notice at time intervals, channels, and frequencies customarily used by the TPWC to broadcast similar notices of opening or closure.

§ 658.25 Size restrictions.

There are no minimum size requirements for shrimp harvested in the fishery conservation zone.

BILLING CODE 3510-22-M

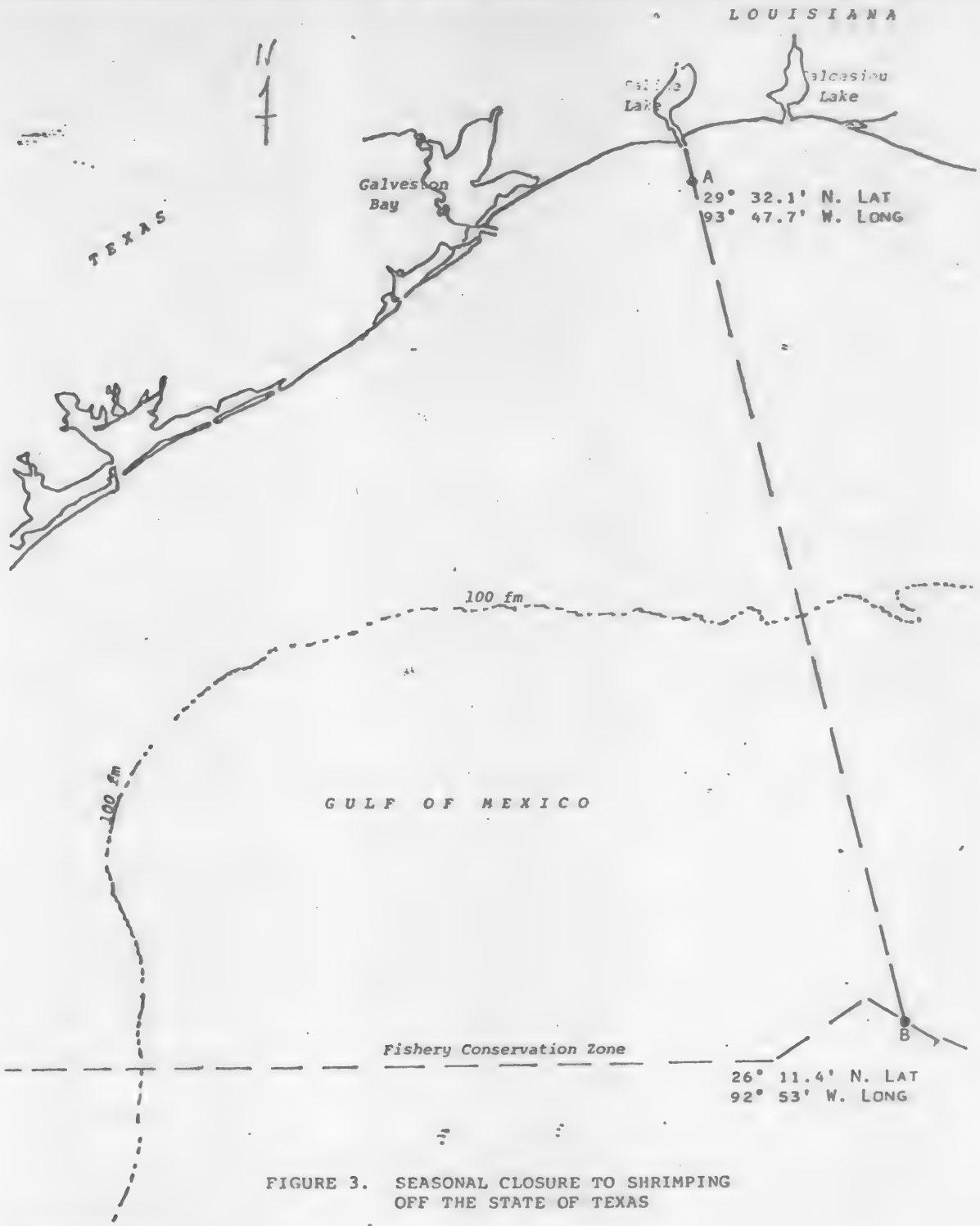


FIGURE 3. SEASONAL CLOSURE TO SHRIMPING OFF THE STATE OF TEXAS

BILLING CODE 3510-22-C

C. Fishery Management Plan for the Shrimp Fishery of the Gulf of Mexico

Table of Contents

2.0 Introduction
2.1 Goal and Objectives
2.2 Management Measures Considered and Adopted
2.3 Operational Definitions of Terms Used
3.0 Description of Fishery
3.1 Area and Stocks Involved
3.2 History of Exploitation
3.2.1 Domestic Fishery
3.2.1.1 Description of User Groups
3.2.1.2 General Description of Fishery Effort
3.2.1.3 Catch Trends
3.2.1.3.1 Commercial Catch Trends by Species
a. Annual Catch Patterns
b. Area Distribution of the Catch
c. Month, Depth, and Size Patterns in Catch of Brown, White, and Pink Shrimp
d. Catch by Size, State, and Species for Brown, White, and Pink Shrimp
3.2.1.3.2 Landing Trends by State
3.2.1.4 Description of Vessels and Gears Employed
3.2.2 History of Foreign Exploitation
3.2.2.1–3.2.2.3 General Description of User Groups, Fishing Effort, Vessels and Gear Employed
3.3 History of Management
3.3.1 Management Institutions, Policies, Jurisdiction
a. Alabama
b. Texas
c. Louisiana
d. Mississippi
e. Florida
3.3.1.1 Regulatory Measures Employed to Regulate the Fishery
a. Legal Size of Shrimp; Catch Limits
1. Texas
2. Louisiana
3. Mississippi
4. Alabama
5. Florida
b. Licensing of Vessels and Fishermen
1. Texas
2. Louisiana
3. Mississippi
4. Alabama
5. Florida
c. Season
1. Texas
2. Louisiana
3. Mississippi
4. Alabama
5. Florida
d. Restricted Waters
1. Texas
2. Louisiana
3. Mississippi
4. Alabama
5. Florida
3.3.1.2 Consistency Requirements of Coastal Zone Management Act
3.3.2 Management and Regulation of Foreign Fishery
3.4 History of Research
3.5 Socioeconomic Characterization
3.5.1 Output of the Subject Domestic Reported Commercial Fishery
3.5.1.1 Ex-vessel Value of the Catch
a. Area Distribution of the Value of the Catch
b. Price Structure Sensitivity to Size Distribution of the Catch
3.5.1.2 Wholesale Value of the Product
3.5.1.3 Domestic Marketing Channels
a. Dealers
b. Processors
d. Brokers and Wholesalers
e. Marketing
f. Pricing of shrimp
3.5.2 Domestic Commercial Fleet Characteristics
3.5.2.1 Total Gross Income of the Fleet
a. Estimates of Net Income of Vessels
3.5.2.2 Investment in Vessels, Boats, and Gear
3.5.2.3 Consideration of Overcapitalization
3.5.2.4 Annual Participation in the Fishery
3.5.2.5 Total Man-Days per Season
3.5.3 Domestic Commercial Processing Characteristics
3.5.3.1 Total Gross Income from the Shrimp and All Related Fisheries
3.5.3.2 Investment in Plant and Equipment
3.5.3.3 Total Employment and Labor Income
3.5.4 Recreational Fishing Characteristics
a. Florida West Coast
b. Alabama
c. Mississippi
d. Louisiana
e. Texas
f. Personal Communications from Fishery Managers
1. Florida West Coast
2. Alabama
3. Mississippi
4. Louisiana
5. Texas
3.5.5 Subsistence Shrimping
3.5.6 Indian Treaty Fishing Characteristics
3.5.7 Output of Domestic Commercial Bait-Shrimp Fishery
a. Florida
b. Alabama
c. Mississippi
d. Louisiana
e. Texas
3.5.8 Area Community Characteristics
3.5.8.1 Total Population
3.5.8.2 Total Employment in Shrimp Fishery
3.5.8.3 Relationship of Shrimp Fisheries to Total Work Force
3.6 Interaction Between and Among User Groups
3.6.1 Shrimpers Interactions
3.6.2 Prevalent Conflicts with Shrimpers and Other National Interests
3.6.2.1 Incidental Catch of Finfish by Shrimpers and of Shrimp by Groundfish Fishermen
3.6.2.2 Habits, Distribution, and incidental Capture of Sea Turtles in the Gulf of Mexico
3.7 State and Federal Revenues Derived from the Shrimp Fishery
4.0 Biology Descriptors
4.1 Life History Features
a. General Features of the Species
b. Sexual Maturity
c. Spawning, Larval Development, Recruitment of Postlarvae to Either Estuaries or Fishing Grounds
1. Brown Shrimp
2. White Shrimp
3. Pink Shrimp
4. Royal Red Shrimp
5. Rock Shrimp
6. Seabob Shrimp
d. Emigration of Brown, White, and Pink Shrimp From Estuaries
1. Brown Shrimp
2. White Shrimp
3. Pink Shrimp
e. Migration Patterns in Offshore Waters
1. Brown Shrimp
2. White Shrimp
3. Pink Shrimp
4. Royal Red and Rock Shrimp
4. Seabob Shrimp
f. Substrate
g. Food
1. Larval Stages
2. Juveniles to Adults
h. Predation
i. Growth Rates
1. General Considerations
2. Brown Shrimp
3. White Shrimp
4. Pink Shrimp
5. Royal Red and Seabobs
j. Mortality Rates
k. Yield per Recruit
1. Brown Shrimp
2. White Shrimp
3. Pink Shrimp
l. Temperature and Salinity
m. Migration and Spawning
n. Bioeconomic Models
4.2 Stock Unit
4.3 Catch-Effort Data
4.4 Survey and Sampling Data
4.5 Habitat
4.5.1 Physical Description of the habitats
4.5.1.1 Bottom Types
4.5.1.1.1 Offshore Bottom Types
4.5.1.1.2 Estuarine Bottom Types
4.5.1.2 Surface Water Discharge
4.5.1.3 Estuarine Salinity
4.5.1.4 Estuarine Access
4.5.1.5 Non-Salinity Water Quality
4.5.1.6 Currents
4.5.2 Habitat Concerns
4.6 Quality of Data
4.7 Current Status of the Stocks
4.7.1 Maximum Sustainable Yield (MSY)
4.7.1.1 Explanation and Specification of MSY
4.7.1.2 Technical Description of MSY Calculations
a. Surplus Production Models
b. Modification of Surplus Yield Estimates for Penaeid Shrimp
4.8 Estimates of Future Stock Conditions
5.0 Catch and Capacity Descriptors
5.1 Domestic Annual Capacity(DAC)
5.2 Data and Analytical Approach
5.3 Expected Domestic Annual Harvest (DAH)
5.3.1 Expected DAH for the Combined Species
5.3.2 Expected DAH OF Royal Red Shrimp
5.4 Domestic Annual Processing Capacity (DAP)
5.4.1 Data Which Shrimp Processors Must Submit to the Secretary of Commerce to Calculate DAP
5.5 Additions to DAH to Account for Joint Ventures
6.0 Optimum Yield (OY)
6.1 Determination of Optimum Yield (OY)
6.2 Specification of Optimum Yield
6.2.1 Shrimp Other Than Royal Red Shrimp
6.2.2 Royal Red Shrimp

6.3 Alternatives to Optimum Yield Considered and Rejected
6.3.1 Optimum Yield for Brown, White and Pink Shrimp to be Set at MSY
6.3.2 Fishing to Stop When Optimum Yield is Reached for Brown, White and Pink Shrimp
6.3.3 Optimum Yield for Royal Red Shrimp to be Set Above MSY
6.3.4 Optimum Yield for Royal Red Shrimp to be Set at MSY With Fishing to be Permitted to Exceed OY
6.3.5 Optimum Yield for Royal Red Shrimp to be Set Below MSY
6.3.6 Optimum Yield Set at Higher Estimate of ABC
7.0 Total Allowable Level of Foreign Catch (TALFF)
7.1 Brown, White, and Pink Shrimp
7.2 Royal Red Shrimp
7.3 Seabob and Rock Shrimp
8.0 Management Regime
8.1 Areas and Stocks Involved
8.2 Management Unit and Period
8.2.1 Management Unit
8.2.2 Management Period
8.3 Problems in the Fishery
8.4 Objectives
8.4.1 Specific Management Objectives
8.4.2 Alternative Objectives
a. Alternative 1
b. Alternative 2
c. Alternative 3
d. Alternative 4
e. Alternative 5
8.5 Management Measures and Rationale
8.5.1 Management Measures Considered and Adopted
8.5.1.1 Optimize the Yield of Shrimp Recruited to the Fishery
Measure 1
Measure 2
Measure 3
8.5.1.2 Encourage Adequate Habitat Protection Measures
Measure 4
8.5.1.3 Coordinate, Where Feasible, the Gulf Shrimp Management Programs
Measure 5
Measure 6
8.5.1.4 Promote Consistency with the Endangered Species Act and Marine Mammals Protection Act
Measure 7
8.5.1.5 When Appropriate, Minimize the Incidental Capture of Finfish by Shrimpers
Measure 8
8.5.1.6 Minimize Conflicts Between Shrimp and Stone Crab Fishermen
Measure 9
8.5.1.7 Minimize Adverse Effects of Underwater Obstructions to Shrimp Trawling
Measure 10
8.5.1.8 Provide for a Statistical Reporting System
Measure 11
8.5.2 Alternative Management Measures Considered but not Adopted
8.5.2.1 No Action
8.5.2.2 Size and/or Season regulations
8.5.2.3 Spawning Area Closures
8.5.2.4 Licensing and Data Collection
8.5.2.5 Limited Entry and Gear Restrictions
8.5.2.6 Recommend Consideration to Change Endangered Species Act to Permit Incidental Catch and Release of Sea Turtles
8.5.3 Management Measures for Foreign Fishing
8.5.4 Relationship of Recommended Measures to Existing Laws and Policies
8.5.4.1 Other Fishery Management Plans Prepared by the Council or the Secretary
8.5.4.2 Federal Laws and Policies
8.5.4.3 State Laws and Policies
a. Texas Laws and Policies
b. Louisiana Laws and Policies
c. Mississippi Laws and Policies
d. Alabama Laws and Policies
e. Florida Laws and Policies
8.6 Enforcement Requirements
8.7 Cooperative Research Requirements
8.8 Permit Requirements
8.9 Financing Requirements
8.9.1 Management and Enforcement Costs
8.9.2 Expected State and Federal Revenues, Taxes and Fees
9.0 Statement of Council Intention to Review the Plan After Approval by the Secretary

2.0 Introduction

The Fishery Conservation and Management Act of 1976 (Pub. L. 94–265) provides for exclusive United States management authority over the fishery resources within a fishery conservation zone extending from the seaward boundary to the United States territorial sea (three nautical miles for the Gulf of Mexico states of Louisiana, Mississippi, and Alabama and nine nautical miles for Texas and the west and northwest coasts of Florida) to a point 200 miles from shore. Responsibility for developing a shrimp fishery management plan for the Gulf of Mexico is vested in the Gulf of Mexico Fishery Management Council; and implementation and enforcement of any regulations pertinent to the management of fisheries within the fishery conservation zone are the responsibility of the Secretary of Commerce and Secretary of the Department wherein the U.S. Coast Guard is located.

Successful implementation of the plan will require unity of purpose between Federal regulations and those of the five Gulf states (Florida, Alabama, Mississippi, Louisiana, and Texas). Authority for implementing state regulations is vested in the Florida Department of Natural Resources, the Alabama Department of Conservation and Natural Resources, the Mississippi Marine Conservation Commission, the Louisiana Wildlife and Fisheries Commission, and the Texas Parks and Wildlife Commission.

The fishery addressed is comprised of six species, occurring in the area of jurisdiction of the Gulf of Mexico Fishery Management Council as well as in the territorial seas adjacent thereto and the associated bays, inlets, wetlands, and upland areas as appropriate. Species include brown shrimp (*Penaeus aztecus* Ives), white shrimp (*Penaeus setiferus* Linnaeus), pink shrimp (*Penaeus duorarum* Burkenroad), and royal red shrimp (*Hymenopenaeus robustus* Smith [1]), plus seabobs (*Xiphopeneus kroyeri* Heller) and rock shrimp (*Sicyonia brevirostris* Stimpton), which are incidental bycatch. The management unit is to be equal to the fishery throughout its range; however, federal implementation will occur only in the fishery conservation zone.

Biological aspects of the shrimp species have been reviewed, and the maximum probable catch is estimated at: (see Sec. 4.7.1.1)

Brown shrimp—132 million pounds (tails) per year
White shrimp—64 million pounds (tails) per year
Pink shrimp—20 million pounds (tails) per year
Royal red shrimp—0.392 million pounds (tails) per year

Each year's take of brown, white, and pink shrimp will be heavily influenced by water salinity and temperature during critical periods of estuarine shrimp growth. Maximum sustainable yield (MSY) estimates for the seabobs and rock shrimp cannot be made with any authority because they are caught incidentally by fishermen trawling for the other species.

Seabobs and rock shrimp are caught incidental to the three main species of penaeid shrimp. MSY estimates are weakened because of lack of data.

None of the stocks appear to be biologically overfished.

Major concern for future stocks is related to concern for adequate habitat, particularly for the estuarine-dependent brown, white, and pink shrimp, which account for most of the annual shrimp harvest.

The effects of shrimping on sea turtles and incidentally caught finfish are considered in the plan.

The fishery is the most valuable and probably the most diverse in the nation. Harvesters include (1) a large commercial fleet fishing the inshore, nearshore Gulf, and open Gulf waters, (2) an undetermined (but large) number of recreational shrimpers mainly fishing the inshore and nearshore Gulf waters, and (3) a substantial number of bait shrimpers mainly fishing the inshore waters. Processed products include frozen, canned, fresh, and breaded shrimp as well as a host of specialty

[1] The genus *Hymenopenaeus* is the same as *Pleoticus* according to Isabel Farfante.

items. Present management regimes differ in the fishery over the allowable size of shrimp at first harvest as size is related to whom can harvest and process the shrimp.

Unfortunately, socioeconomic data are insufficient for this complex fishery to evaluate fully the relative needs of various user groups for shrimp of different sizes. Care has therefore been taken in making recommendations to reduce the waste of current culling practices so that one user group will not be favored over another. No recommendations are made on limiting fishing effort because the resource is not biologically overfished. There is insufficient socioeconomic data to suggest methods or reasons, consistent with FCMA, to limit entry at this time.

During a period of public review of the Draft Fishery Management Plan and Environmental Impact Statement, 21 public hearings were held and written comments were received by mail. Public comments and responses are contained in the Final Environmental Impact Statement.

The plan is to be reviewed annually so that management measures can be evaluated for their fairness and effectiveness and so that other methods of optimizing yield can be assessed.

Problems in the Fishery (See Section 8.3)

The Council has identified the following problems associated with the fishery and the present management regime and has prepared the plan objectives to address and alleviate them. In a free access fishery a management regime to maximize protein yield and economic return of the fisherman is of importance.

(1) Conflict among user groups as to area and size at which shrimp are to be harvested.

(2) Discard of shrimp through the wasteful practice of culling.

(3) The continuing decline in the quality and quantity of estuarine and associated inland habitats.

(4) Lack of comprehensive, coordinated and easily ascertainable management authorities over shrimp resources throughout their ranges.

(5) Conflicts with other fisheries such as the stone crab fishery in southern Florida, the groundfish fishery of the north central Gulf, and the Gulf's reef fish fishery.

(6) Incidental capture of sea turtles.

(7) Loss of gear and trawling grounds due to man-made underwater obstructions.

(8) Partial lack of basic data needed for management.

2.1 Goal and Objectives

Goal: To manage the shrimp fishery of the United States waters of the Gulf of Mexico in order to attain the greatest overall benefit to the nation with particular reference to food production and recreational opportunities on the basis of the maximum sustainable yield as modified by relevant economic, social or ecological factors.

Objectives: 1. Optimize the yield from shrimp recruited to the fishery.

2. Encourage habitat protection measures to prevent undue loss of shrimp habitat.

3. Coordinate the development of shrimp management measures by the GMFMC with shrimp management programs of the several states, where feasible.

4. Promote consistency with the Endangered Species Act and the Marine Mammal Protection Act.

5. Minimize the incidental capture of finfish by shrimpers, when appropriate.

6. Minimize conflicts between shrimp and stone crab fishermen.

7. Minimize adverse effects of underwater obstructions to shrimp trawling.

8. Provide for a statistical reporting system.

2.2 Management Measures Considered and Adopted (See Sec. 8.5.1.1)

In order to obtain the above objectives, the Council has adopted the following management measures:

Measure 1: Establish a cooperative permanent closure with the State of Florida and the U.S. Department of Commerce of the area delineated in Table 8.3–1 to protect small pink shrimp until they have generally reached a size range larger than 69 tails to the pound.

Measure 2: Establish a cooperative closure of the territorial sea of Texas and the adjacent U.S. FCZ with the State of Texas and the U.S. Department of Commerce during the time when a substantial portion of the brown shrimp in these waters weigh less than a count of 65 tails to the pound (39 heads-on shrimp to the pound).

Measure 3: Recommend that all Gulf states consider establishing shrimp management sanctuaries in important segments of nursery grounds under their sole jurisdiction.

Measure 4: The Gulf of Mexico Fishery Management Council has established an internal committee to review and assess the status of Gulf fishery habitats, with particular attention to those factors which might further stimulate "the downward trends in quality and quantity of fish habitats." (Atlantic States Marine Fisheries Commission et al., 1977.)

Measure 5: The Gulf states are encouraged to adopt flexible management procedures which would provide regulation by administrative agencies of the shrimp resources in inland waters and territorial seas.

Measure 6: The Gulf states are encouraged to adopt reciprocal internal management decisions flexible enough to allow joint management of shrimp with other states and with the Department of Commerce.

Measure 7: Develop and implement an educational program to inform shrimpers of the current status of sea turtle populations and of proper methods of resuscitation and return to sea of incidentally captured sea turtles.

Measure 8: Encourage research on and development of shrimping gear in order to reduce the incidental catch without decreasing the overall efficiency of shrimping or excessively increasing the cost of gear.

Measure 9: Consistent with the Stone Crab management Plan, establish a seasonal closure of a portion of the Dry tortugas shrimp grounds in order to avoid gear conflicts with stone crab fishermen.

Measure 10: The Gulf of Mexico Fishery Management Council will attempt to reduce, where feasible, the loss of offshore trawlable bottom by establishing within GMFMC, a committee to monitor and review construction of offshore reefs, with attention to the needs of the reef fish and shrimp user groups.

Measure 11: All statistical reporting requirements will be mandatory.

2.3 Operational Definitions of Terms Used

Acceptable Biological Catch (ABC) is a seasonally determined catch that may differ from MSY for biological reasons. It may be lower or higher than MSY in some years for species with fluctuating recruitment. It may be set lower than MSY in order to rebuild overfished stocks.

Annual Crop is a species which is harvested essentially as a 0-year class (less than one year of age).

Boats are crafts that displace less than five gross tons.

Catch Per Unit of Effort (CPUE) is the total number or weight of fish harvested by a defined unit of fishing effort.

Commercial Shrimpers are shrimpers who sell any portion of their catch.

Culling is the practice of discarding those shrimp caught which are smaller than a size the fisherman wishes to retain.

Determination for Total Allowable Level of Foreign Fishing (FTALFF). The foreign allowable catch is determined by

deducting the expected domestic annual harvest from the optimum yield.

Detritus is considered as decaying plant material and its associated community of microscopic plants and animals.

Domestic Annual Fishing Capacity (DAFC) is the total potential physical fishing capacity of the fleet, modified by logistic factors. The components of the concept are:

a. An inventory of total potential physical capacity, defined in terms of appropriate vessel and gear characteristics (that is, size, horsepower, hold capacity, gear design, etc.).

b. Logistic factors determining total annual fishing capacity, (that is, variations in vessel and gear performance, trip length between fishing locations and landing points, weather constraints, etc.).

Domestic Annual Processing Capacity (DAPC) is the amount that can be processed if supplies are available.

Equilibrium Yield (EY) is the annual or seasonal harvest that maintains the resource at approximately the same level of abundance (apart from the effects of environmental variation) in succeeding seasons or years.

Estuarine Dependent Species are those organisms that must complete a portion of their life cycle within an estuary.

Expected Domestic Annual Harvest (EDAH) is the total expected catch of the U.S. shrimp fleet.

Fishery conservation Zone (FCZ) is the area of federal jurisdiction, beginning at the outer limit of the states' territorial seas and extending 200 miles from shore.

Fishing Effort is the total fishing gear in use for a specified period of time.

Fishing Mortality includes all deaths to the exploited populations associated with the harvesting practices.

Growth Overfishing is a level of effort which prevents the exploited population from attaining its maximum size.

Incidental Catch refers to the catch of species other than the target species (bycatch).

Inland Waters (inside waters) are areas of state jurisdiction and include all bays and lagoons inland from the baseline from which the territorial sea is measured.

Maximum Economic Yield (MEY) is the level of harvest from the common property resource that maximizes the stream of generated net incomes over time.

Maximum Sustainable Yield (MSY) is an average over a reasonable length of time of the largest catch which can be taken continuously from a stock, under current environmental conditions.

Natural Mortality includes deaths from all causes except capture by man.

Omnivore is an animal which eats whatever dead or alive animal or plant material is available.

Optimum Yield (OY) with respect to the yield from a fishery, means the amount of fish:

(a) which will provide the greatest overall benefit to the nation, with particular reference to food production and recreational opportunities; and

(b) which is prescribed as such on the basis of the maximum sustainable yield from such fishing, as modified by any relevant economic, social, or ecological factor.

Recreational Shrimpers are shrimpers who do not sell their catch.

Recruitment Overfishing is used to denote that level of fishing effort which reduces the spawning stock size to the point where there is a reduction in the amount of young recruited to the fishery.

Spawner-Recruit Relationship is the quantifiable relationship between the number of reproducing adults and the resulting number of young recruited to the fishery.

Stock is a group of fish manageable as a unit.

Target Species are the species at which the fishery is directed.

Territorial Sea is the area of state jurisdiction extending from the baseline to three nautical miles seaward for Alabama, Mississippi, and Louisiana, and to nine nautical miles for Texas and the Florida west and northwest coasts.

Total Allowable Level of Foreign Fishing (TALFF) is any surplus in the optimum yield above the expected domestic annual harvest.

Unit Fishing Effort is a measure of harvesting pressure which has been adjusted to account for differences in the ability of boats and vessels of different types to harvest the resource.

Vessels are crafts with displacement greater than or equal to five gross tons.

Year-class is the fish spawned in a given year.

Yield is the amount of a species harvested by man.

3.0 Description of Fishery

3.1 Area and Stocks Involved

The fishery being addressed is comprised of the species listed below and occurs in the area of jurisdiction of the Gulf of Mexico Fishery Management Council as well as in the area of jurisdiction of the various Gulf states including their territorial seas, associated bays, inlets, wetlands, and upland areas as appropriate.

Consideration of this large area is necessary because of the migratory natures of the exploited species and fishermen, the critical role of estuaries in the life cycles of the dominant shrimp species, and the impacts upland alterations may have on the quality of shrimp habitat.

Shrimp species within the fishery are:

Brown shrimp *(Penaeus aztecus* Ives)
White shrimp *(Penaeus setiferus* Linnaeus)
Pink shrimp *(Penaeus duorarum* Burkenroad)
Royal red shrimp *(Hymenopenaeus robustus* Smith)
Seabobs *Xiphopeneus Kroyeri* Heller) Incidental bycatch
Rock shrimp *Sicyonia brevirostris* Stimpton) Incidental bycatch

In addition to these shrimp species, shrimpers also catch sea turtles and other shellfish and finfish. The sea turtle catch is of concern to the development of this plan because all the sea turtles which occur in the Gulf are listed as either endangered or threatened under the U.S. Endangered Species Act which prohibits capture of endangered species. Though primary responsibility for protection of these sea turtle species lies with the National Marine Fisheries Service and the U.S. Fish and Wildlife Service, the plan contains appropriate suggestions to minimize the impact on sea turtle populations. The incidental catch of other shellfish and finfish is also of concern because much of this catch is discarded at sea. Since much of the discarded catch is dead or dies as a result of being caught, this operation largely represents a direct conversion of national resources into food for scavengers. Many of these resources can be used by other national interests. Primary responsibility for managing these resources lies with the GMFMC, NMFS, and the Gulf states. Management plans are currently being prepared by GMFMC for two major bycatch groups—groundfish and reef fish—in which appropriate measures are suggested to reduce this bycatch. In addition, the groundfish management plan contains a thorough treatment of current efforts to develop markets for these discarded species.

Brown shrimp range along the north Atlantic and Gulf of Mexico coasts from Martha's Vineyard, Massachusetts, to the northwestern coast of Yucatan. The range is not continuous but is marked by an apparent absence of brown shrimp along Florida's west coast between the Sanibel and the Apalachicola shrimping grounds (Perez Farfante, 1969). In the U.S. Gulf of Mexico, catches are high along the Texas, Louisiana, and Mississippi coasts.

Mark-recapture experiments indicate a mixing of brown shrimp populations along the north central and

northwestern Gulf coast. A southward drift of brown shrimp off the Texas coast towards Mexico has been proposed (Gunter, 1962). There is some speculation that the Mississippi River may act as a barrier to east-west migration.

Brown shrimp are caught out to at least 50 fathoms, though most come from less than 30 fathoms. The season begins in May, peaks in June and July, and gradually decline to an April low.

White shrimp range along the Atlantic coast from Fire Island, New York, to Saint Lucie Inlet, Florida, and along the Gulf coast from the mouth of the Ochlachonee River, Florida, to Campeche. In the Gulf there are two centers of abundance: one along the Louisiana coast and one in the Campeche area (Perez Farfante, 1969).

There appears to be a general mixing of white shrimp west of the Mississippi River to at least the northeast coast of Mexico, with an observed northward migration along the Mexico-Texas shore to at least Aransas Pass, Texas, during the spring (Lindner and Anderson, 1956). A reciprocal southward movement in the fall and winter has been proposed (Gunter, 1962). It has been suggested that again the Mississippi River may act as a barrier in east-west migration (Linder and Anderson, 1956; Perez Farfante, 1969).

White shrimp are a comparatively shallow-water shrimp, with most of the catch coming from less than 15 fathoms. Annual catch has two peaks: the major one in late summer-early fall, with an October high; the minor one is the "Easter fishery" on over-wintered shrimp which peaks in May. Largest U.S. catches occur west of the Mississippi River to the Freeport, Texas, area, though catch is considerable along the entire north central and western Gulf.

Pink shrimp range along the Atlantic from lower Chesapeake Bay south to around the Florida Keys and up and around the Gulf coast to Isla Mujeres, Mexico. They are also found in the Bermuda Islands and the northern coast of Yucatan. Major concentrations are off southwest Florida and in the southeastern part of Golfo de Campeche (Perez Farfante, 1969).

The two major pink shrimp grounds in the United States are the Tortugas and Sanibel grounds in southwestern Florida. There is little movement of shrimp between these grounds, and they are derived from largely different estuarine areas (Costello and Allen, 1965).

Pink shrimp catch comes mainly from less than 25 fathoms, with a peak catch at 11 to 15 fathoms. Because of continuous recruitment in southeastern Florida, the catch exhibits a broad peak October through May. U.S. catch is mainly restricted to Florida and is greatest in southwestern Florida.

Royal red shrimp are deepwater shrimp occurring as far north as Cape Hatteras, North Carolina, to as far south as the coast of the Guianas, and primarily in depths of 140 to 300 fathoms. Concentrations of royal red are known to exist in three geographical areas: (1) East of St. Augustine, Florida, in the western Atlantic; (2) south-southeast of the Dry Tortugas in the Florida Straits; and (3) southeast of the Mississippi River Delta in the Gulf of Mexico (Roe, 1969).

Seabobs are caught most often in shallow waters at six to seven fathoms or less and almost never in estuaries (Renfro and Cook, 1963). U.S. catch is highest along the Louisiana coast in October through December.

Rock shrimp occur along the Atlantic coast from Virginia to the Florida Keys and up along the Gulf coast to Cabo Catoche, Mexico (Cobb, et al., 1973; Hildebrand, 1954). Major concentrations occur at Cabo Catoche, Mexico, and in the Cape Canaveral, Florida, area (Christmas and Etzold, 1977). Major Gulf catch (1971–1975) comes from the Panhandle area of Florida at depths of 10 to 22 fathoms (Christmas and Etzold, 1977).

3.2 History of Exploitation

3.2.1 Domestic Fishery

3.2.1.1 Description of User Groups

The shrimp fishery of the Gulf can be divided into four general categories of users—harvesters (directly involved in the taking of shrimp), processors, marketers, and consumers.

The actual taking of shrimp is done by recreational fishermen, commercial bait shrimpers, and commercial (food) shrimpers. The commercial shrimp user category includes employees as well as owner's of vessels and may be divided into smaller boat operations, which are restricted to inland bay and shallow offshore activities, and the offshore vessels, which range from the territorial seas out to the limits of the FCZ and into foreign waters.

The economics of the shrimp fishery include vessel owners who do not actually shrimp themselves, the boatyard and gear industry, and the suppliers of ice and fuel (essential inputs for shrimping operations).

Processors include the shrimper as a first level processor, if he heads the shrimp. fish houses may perform one or all processing activities such as heading, peeling, grading, packing in ice, and freezing, cooking, or drying. The non-shrimper processors handle the shrimp between the fish house and the purchaser. The three basic types of processors are: (1) Producers of "green" (fresh) or frozen shrimp; in 1974 they accounted for 86.25 million pounds valued at $152.6 million, or 59 percent of the total value of shrimp produced in the Gulf that year; (2) "breaders," who in 1974 produced 52.66 million pounds of breaded shrimp (including imports) valued at $75.7 million, or 29 percent of the total value of shrimp processed in the Gulf region (Florida and Texas accounted for 91 percent of the breaded shrimp); (3) canners, who generally use small- to medium-sized shrimp; such canning plants are located primarily in South Louisiana and Mississippi, with the greatest concentration found in the New Orleans area. They accounted for $13.1 million worth of canned shrimp represented by 1.9 million standard cases, or seven percent of the total value of all shrimp processed in the Gulf region. In addition, there is a wide array of specialty items such as dried shrimp, gumbo, etc.

Restaurants are also an important processing entity. It is estimated that more shrimp are consumed in restaurants than used in homes. The role of restaurants as processors ranges from minimal, limited to the actual cooling process, to the handling of shrimp in raw and unpeeled form.

Marketing of shrimp involves every stage of the industry; there also are groups which engage solely in marketing, with their processing function limited to possible repackaging. Transportation of shrimp is usually handled by trucks operated by the wholesale marketing entitles.

Consumers are given a choice of several different ways to purchase shrimp, ranging from heads-on to stove-ready status.

3.2.1.2 General Description of Fishery Effort

Prior to the introduction of the otter trawl in 1917, most shrimp were commercially harvested in shallow inshore areas with haul seines. White shrimp were the main shrimp caught and marketed until the early 1950's; quantities of seabobs and brown shrimp were used for dried products. During these years fishing efforts were concentrated in areas where white shrimp were abundant. From 1917 to the late 1940's, most shrimp were caught from vessels rigged with single otter trawls which operated within about six miles of shore. However, vessels occassionally went out about ten miles and, in some instances off Louisana, out fifty miles. By the early 1950's, increased

markets for brown and pink shrimp and the discovery of new fishing grounds initiated a period of rapid expansion of the shrimp industry. As a result, some vessels began to move farther offshore because of the increasing difficulty of making profitable catches on traditional fishing grounds. By the early 1960's, U.S. shrimp vessels were fishing off the coasts of Mexico and South America. A major change in gear methodology took place in the late 1950's with the introduction of double-rig trawling. Two small trawls were pulled instead of a single large net, resulting in a substantial increase in catch efficiency and a reduction of handling problems. Double-rig trawls were used by most vessels fishing for pink and brown shrimp. More recently the twin-trawl has become popular in the offshore Gulf shrimp fleet because of its efficiency (Figure 3.2–11). With this arrangement four small trawls are towed instead of two from a single vessel. The inshore shrimp fishery is primarily confined to the internal waters fo each of the Gulf states. There are numerous small boats rigged with single otter trawls which harvest shrimp commercially from the bays and marshes. Some of the boats may fish in the Gulf during favorable weather conditions, especially for white shrimp.

Fishing efforts for royal red shrimp occur intermittently when shrimping along the coast is poor. Royal red shrimp are harvested from vessels using a single trawl. The deep-water habitat of the species necessitates the use of heavier inches and cables than are used to catch shallow-water shrimp species and, in general, the use of larger vessels.

The live-bait shrimp fishery is generally limited to the shallow inshore waters of the Gulf. Bait shrimp catches on the Florida west coast consist primarily of pink shrimp, which are harvested in shallow grass beds from boats equipped with single or double side-frame trawls. The bait shrimp fishery in the remaining Gulf states is usually dependent upon white and brown shrimp, which are harvested with boats rigged with a single otter trawl. Mortality of the live shrimp is minimized by trawling for short durations during the cooler early morning hours and then rapidly sorting the catch. The limited capacity of live-holding facilities aboard the boat and the perishability of live shrimp probably restrict bait shrimping operations to areas near the dealer where the catch is sold. The dealer in turn, however, may transport live shrimp considerable distances, i.e., 200 or more miles.

Recreational shrimping efforts are generally concentrated in shallow inshore waters, though few individuals may occasionally venture into the territorial sea during favorable weather conditions. It is unlikely, however, that any recreational shrimpers operate in the fishery Conservation Zone. The boats used in the recreational shrimp fishery are usually outboard or inboard pleasure craft rigged tow for a single otter trawl ranging from about 16 to 40 feet in width. Although most of the recreational catch is harvested with otter trawls, other gears such as cast nets, wing nets, channel nets, and dip nets may account for a substantial amount of the harvest in localized areas.

3.2.1.3 Catch Trends

Trends in the shrimp fishery discussed here are based on two data sets. The first is the reported commercial catch by species (U.S. Department of Commerce, 1959.1975). The second is the reported commercial landings by state (U.S. Department of Commerce, 1880–1975). These two data sets are not identical. The catch is the amount of shrimp caught in a specific inshore or offshore area. Landings are the total catch, whose origin may not be known, delivered at a port and sold commercially.

3.2.1.3.1 Commercial Catch Trends by Species

Annual Catch Patterns.—Average annual reported commercial catches of shrimp (plus or minus one standard deviation) in the U.S. Gulf are:

Brown shrimp,* 60.4 ± 17.4, million pounds (tails)
White shrimp,* 32.8 ± 8.9, million pounds (tails)
Pink shrimp,* 12.7 ± 2.2, million pounds (tails)
Royal red shrimp,* 0.83 ± .091, million pounds (tails)
Seabob shrimp,* 1.4 ± 1.6, million pounds (tails)
Rock shrimp,** .331 ± .358, million pounds (tails)

Three species—brown, white, and pink shrimp—account for 98 percent of the total average catch.

Annual catches of the dominant species (brown, white and pink shrimp) are highly variable. The annual variation has long been a concern to shrimpers, processors, and consumers. As with other annual crops (such as wheat or corn), success is associated with prevalent environmental conditions. In the case of brown, white, and pink shrimp, the effects of environmental forces are most dramatic during the critical esturaine phase of growth (Section 4.1). The variation in the catch of the three minor species appears to be related more to market conditions and the supply of other shrimp than to variation in shrimp abundance.

There are no apparent or significant linear trends in annual catches of brown, white, or pink shrimp (Fig. 3.2–1 and Table 4.7–1). Although annual catches appear somewhat cyclical, they are caused by environmental conditions. A poor year can be followed by an exceptionally good year for any of these species. Catch for a given year appears to be independent of the preceding year's catch, and no spawner-recruit relationship suggests itself.

Annual catch of minor species has tended to increase with time. This increase in catch is associated with an increase in the effort applied to harvest the major species (Table 4.7–6). Annual catch of royal red shrimp has ranged between 4,600 and 270,000 pounds of tails annually but has generally increased at the rate of 14,000 ± 5,000 pounds of tails per year (1963–1976).

Reported catch of seabob shrimp has generally increased over the 1963–1975 period, though the most dramatic increase occurred over the 1971–1975 period (Fig. 3.2–2). The reported catch of seabob shrimp may be much greater incidentally with other shrimp (Table 4.7–8), an increase in effort on white shrimp (as seabobs are an incidental catch to this fishery). Seabobs are retained when the price expected is high or the supply of other shrimp is limited (P. Juneaux, LDWF, personal communication, 1978).

The reported catch of rock shrimp is relatively recent, with the first report occuring in 1971. Catch for the 1971–1976 period is listed in Table 4.7–6. Rock shrimp are mostly caugth incidentally with other species, especially pink shrimp (Table 4.7–9), however, a small directed fishery does exist.

Area Distribution of the Catch

The reported commecial catch of shrimp is classified by NMFS into 21 areas along the U.S. Gulf coast (fig. 3.2–3).

The average annual commercial catch by area is compared for brown, white, and pink shrimp in Fig. 3.2–4 and for royal red, seabob, and rock shrimp in Fig. 3.2–5.

BILLING CODE 3510-22-M

*(1959–1975)
**(1971–1976)

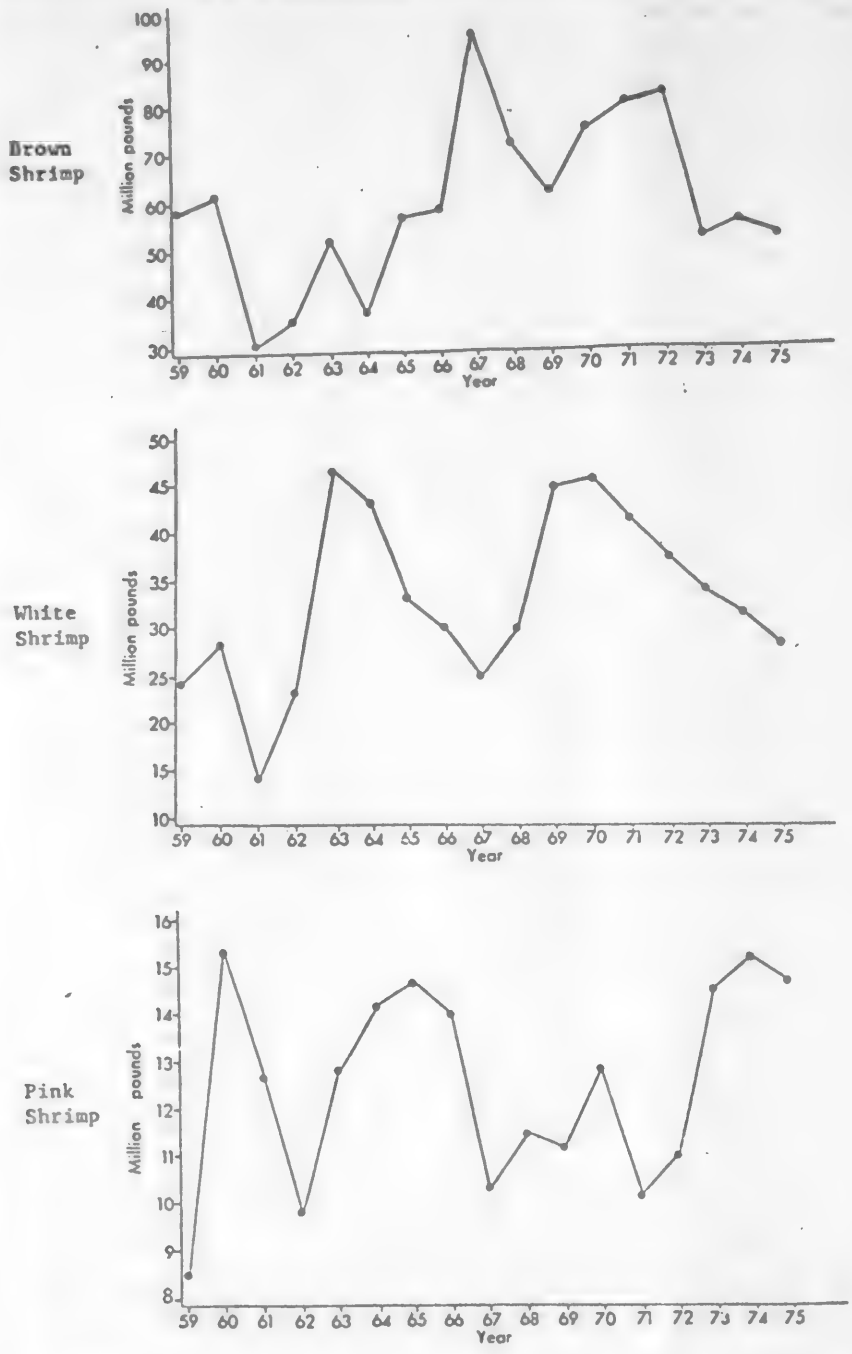
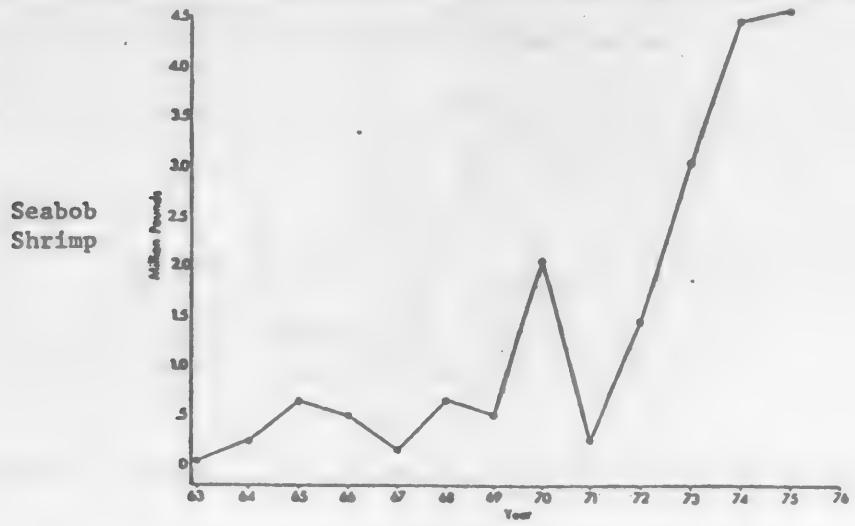


Figure 3.2-1. Trends in annual reported commercial catch of brown, white, and pink shrimp from the US Gulf of Mexico (US Dept. Com., Gulf Coast Shrimp Data, 1963-1975). Weight is in pounds of tails.



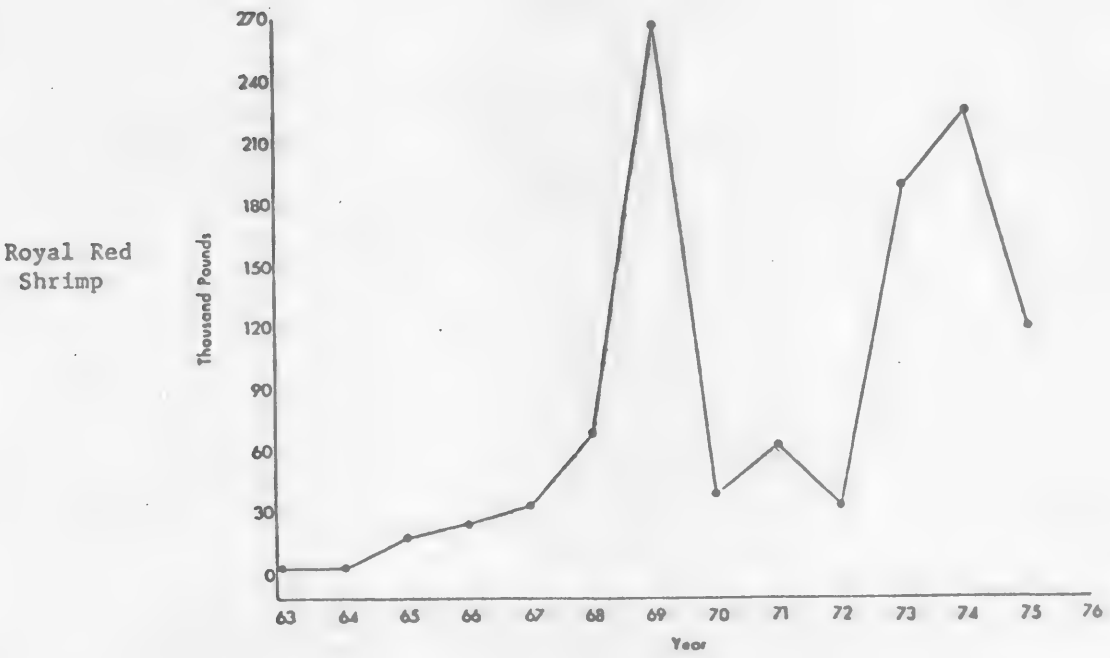
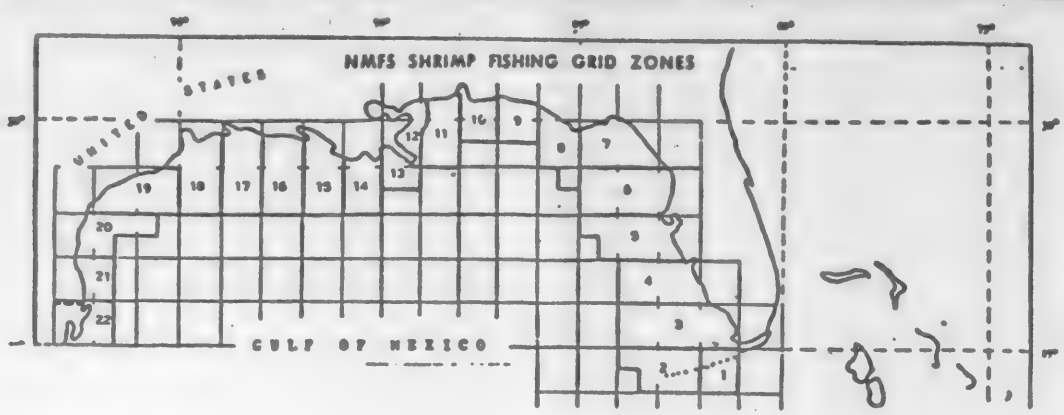


Figure 3.2-2. Trends in annual reported commercial catch of seabob and royal red shrimp from the US Gulf of Mexico (US Dept. Com., Gulf Coast Shrimp Data, 1963-1975). Weight is in pounds of tails.



Area code index to prominant city, bay, or federal game reserve associated with the area:

1. Key West
2. Dry Tortugas
3. Everglades
4. Naples
5. Tampa
6. Tarpon Springs
7. Apalachee
8. Panama City
9. Fort Walton
10. Mobile
11. Biloxi
12. Chandeleur
13. Barataria
14. Terrebonne
15. Atchafalaya
16. Rockerfeller
17. Calcasieu
18. Galveston
19. Freeport
20. Corpus Christi
21. Brownsville

Figure 3.2-3. National Marine Fishery Service Shrimp Fishery Grid Zones in the US Gulf of Mexico (US Department of Commerce, Gulf Coast Shrimp Data, 1959-1975).

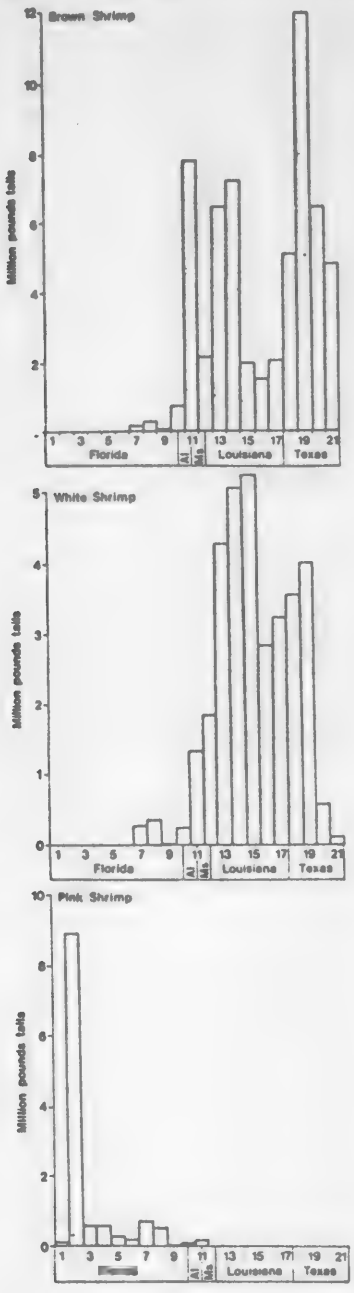


Figure 3.2-4. Average reported commercial catch of brown, white, and pink shrimp along the US Gulf Coast (US Dept. Com., Gulf Coast Shrimp Data, 1959-1975). Catch is represented as averages reported for the 21 NMFS statistical reporting zones along the US Gulf Coast (Fig. 3.2-3).

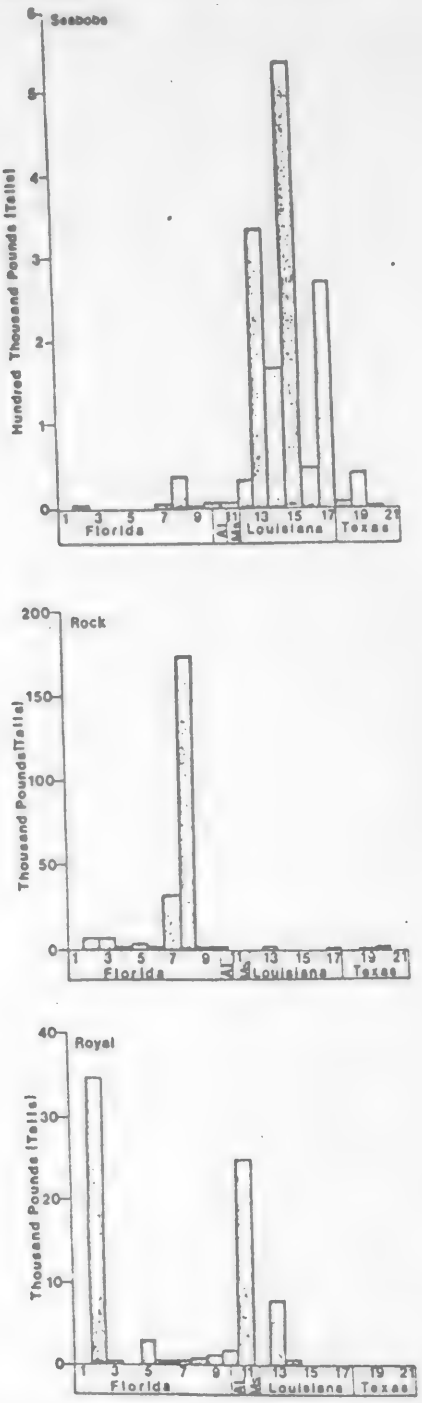


Figure 3.2-5. Average reported commercial catch of seabob (1963-1975), rock (1971-1975), and royal red shrimp (1963-1975) along the US Gulf Coast (US Dept. Com., Gulf Coast Shrimp Data, 1963-1975). Averages are for the 21 NMFS statistical reporting zones (Fig. 3.2-3).

BILLING CODE 3510-22-C

Brown and white shrimp exhibit a similar broad peak in catch from the Apalachee to Brownsville areas. Pink shrimp-catch is substantial in the Key West to Apalachee Bay areas. There is little overlap of dominant pink areas with brown or white shrimp.

Brown shrimp catch normally exceeds two million pounds of tails annually in each of the NMFS grid areas in the Biloxi to Brownsville areas. The Freeport area normally has the largest catch, averaging 12 million pounds of tails annually. White shrimp catch normally exceeds four million pounds of tails annually in the Barataria, Terrebonne, and Atchafalaya areas. Catches from the Rockefeller through Freeport areas are also normally high, averaging above 2.5 million pounds of tails annually. Pink shrimp harvest is concentrated in the Dry Tortugas area with an annual catch of nine million pounds of tails.

There are two main areas for the royal red shrimp catch. One is off the Dry Tortugas area; the other is off the mouth of the Mississippi River and is reported for the Biloxi and Barataria areas. Catch is highest from January through June and in September and occurs at depths of 100 to 300 fathoms. Seabob catch is normally highest in waters associated with the Louisiana coast, peak catch normally occurring in the Atchafalaya area at 0.5 million pounds annually. Rock shrimp catch (1971–1975) is mainly limited to waters associated with Florida. Annual catch is highest in the Panama City and Apalachee areas.

Month, Depth, and Size Patterns in Catch of Brown, White, and Pink Shrimp

Brown and white shrimp exhibit distinct annual cycles in their abundance and size at different depths in the shrimping grounds of the U.S. Gulf. Although pink shrimp have an expected size-depth relationship (Section 4.1), their seasonal and size patterns in reported commercial catch are not as dramatic as those of brown and white shrimp; pink shrimp have a more or less continual recruitment in the Dry Tortugas area and Florida has practiced areal closures to protect undersized pink shrimp. Pink shrimp catch (Fig. 3.2–8) exhibits a peak from October through May at 11 to 15 fathoms. Seasonal patterns in size or depth of catch are not pronounced because of the fairly continual recruitment of pink shrimp in the Dry Tortugas area and closure of the Tortugas shrimp bed by Florida to protect undersized shrimp.

As shown in Fig. 3.2–6, the fishery on 0-year class brown shrimp normally starts in inland waters in May on shrimp of a count greater than 67 tails to the pound. The inshore catch peaks in June at an average catch of 6.6 million pounds of tails. Although it consists mainly of smaller size shrimp, this inshore catch is popular among recreational and small boat commercial shrimpers whose gear does not normnally allow them to fish the open waters of the Gulf.

The offshore fishery for brown shrimp peaks in July and August at depths of 11 to 20 fathoms. The dominant size class in the reported commercial catch is 31 to 40 tails to the pound. The actual average size shrimp caught may be much smaller since a considerable number of undersized shrimp are discarded off the Texas coast (Baxter, 1973; Sections 4.7 and 8.3) and the primary brown shrimp catch during this time also occurs off the Texas coast.

The September brown shrimp catch is dominated by 26 to 30 tails-to-the-pound shrimp at 16 to 20 fathoms. The catch becomes further restricted to deeper waters and larger shrimp in October to December. The January to April pattern is relatively constant, with greatest catch in open Gulf waters of 21 to 40 fathoms and of shrimp of a count less than 21 tails to the pound.

BILLING CODE 3510-22-M

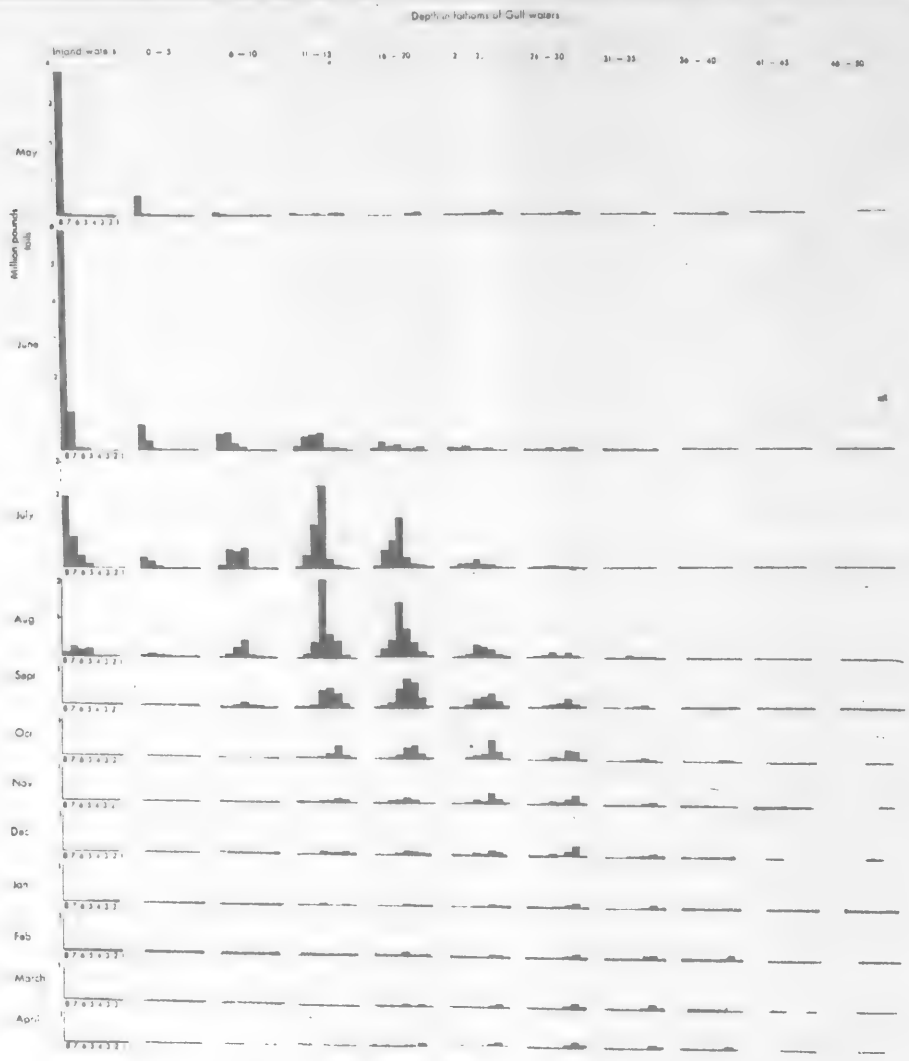


Figure 3.2-6. Brown shrimp average catch in the US Gulf by size, class, depth, month (US Dept. Com., Gulf Coast Shrimp Data, 1959-1975). Code to size of shrimp: 1 = under 15 tails per pound; 2 = 15-20 tails per pound; 3 = 21-25 tails per pound; 4 = 26-30 tails per pound; 5 = 31-40 tails per pound; 6 = 41-50 tails per pound; 7 = 51-67 tails per pound; 8 = 68 and over tails per pound.

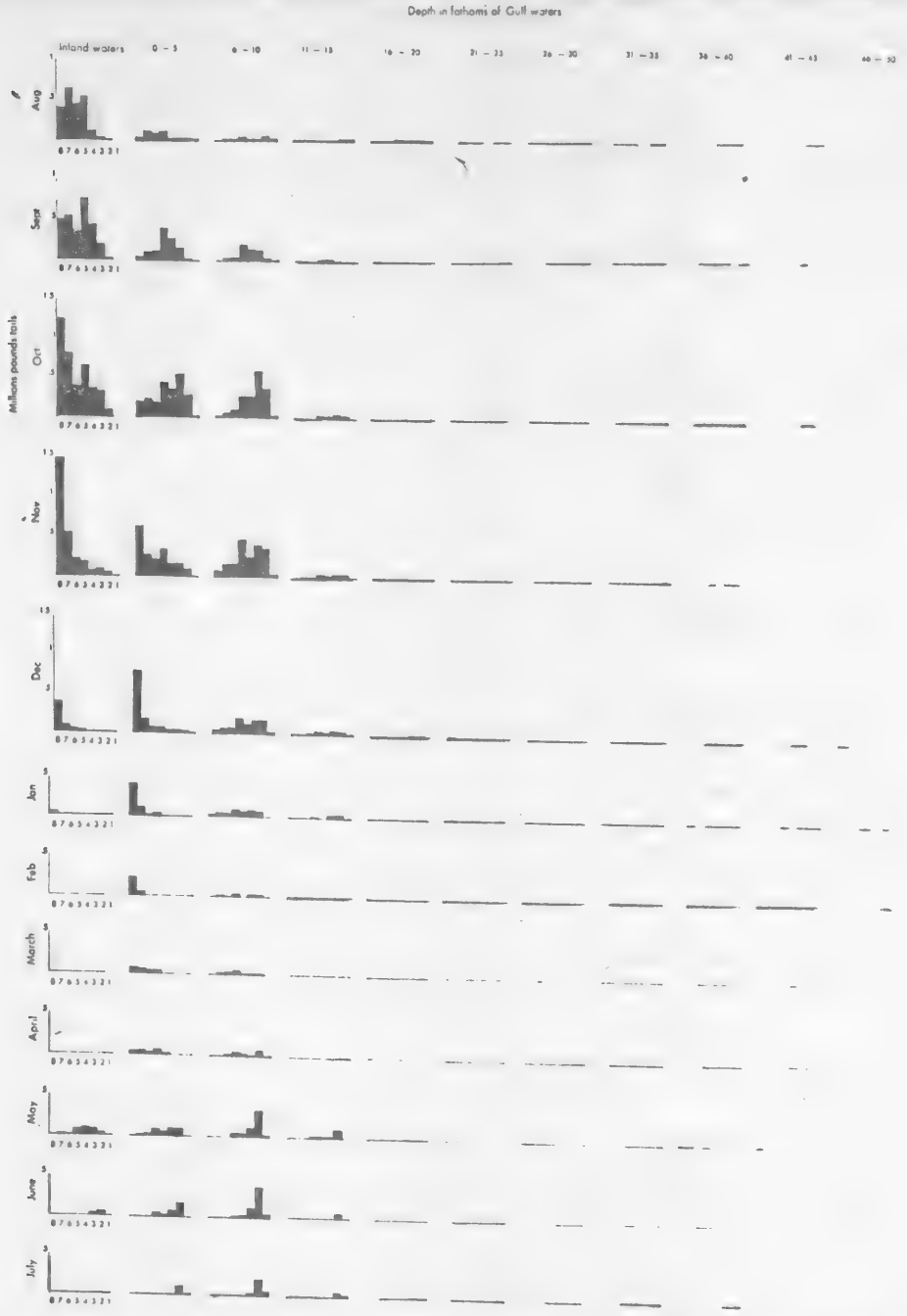


Figure 3.2-7. White shrimp average catch in the US Gulf by size, class, depth, month (US Dept. Com., Gulf Coast Shrimp Data, 1959-1975). Code to size of shrimp: 1 = under 15 tails per pound; 2 = 15-20 tails per pound; 3 = 21-25 tails per pound; 4 = 26-30 tails per pound; 5 = 31-40 tails per pound; 6 = 41-50 tails per pound; 7 = 51-67 tails per pound; 8 = 68 and over tails per pound.

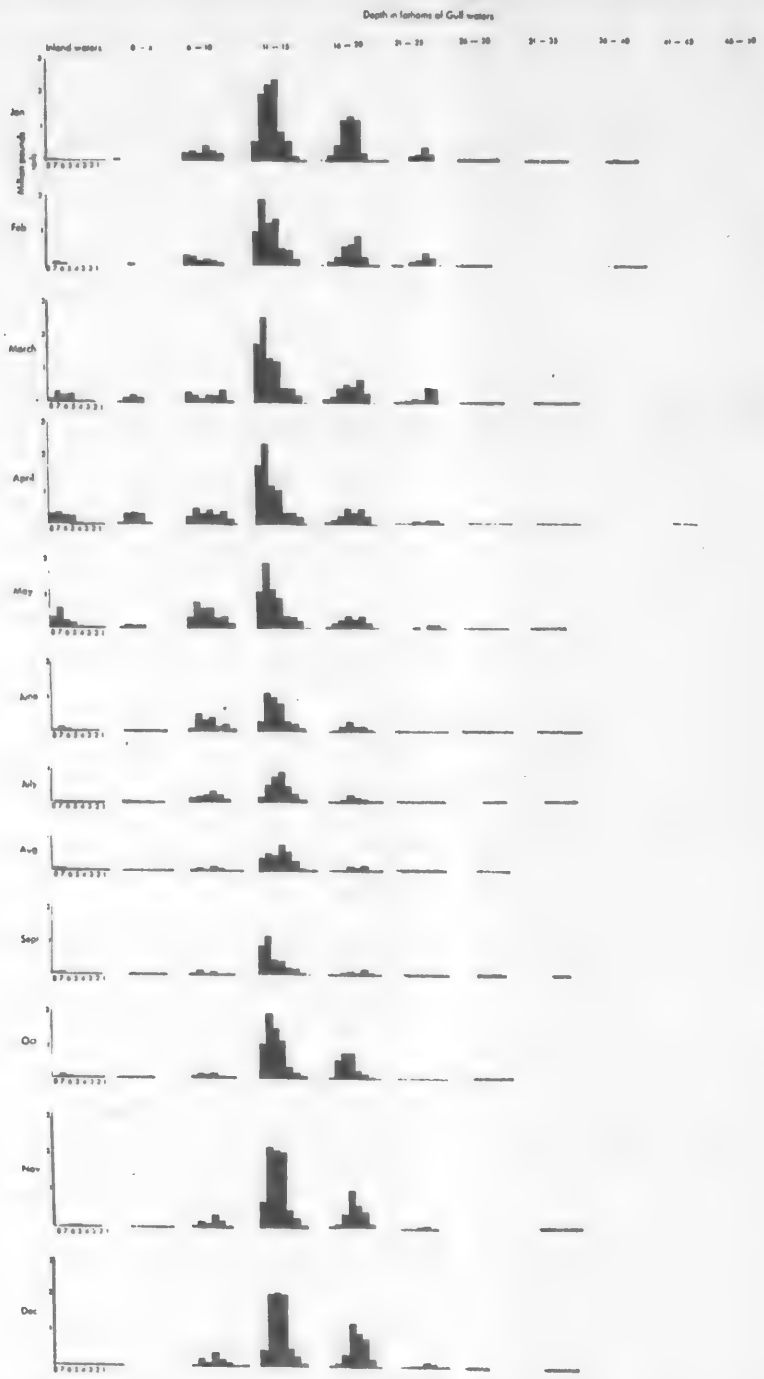


Figure 3.2-8. Pink shrimp average catch in the US Gulf by size, class, depth, month (US Dept. Com., Gulf Coast Shrimp Data, 1959-1975). Code to size of shrimp: 1 = under 15 tails per pound; 2 = 15-20 tails per pound; 3 = 21-25 tails per pound; 4 = 26-30 tails per pound; 5 = 31-40 tails per pound; 6 = 41-50 tails per pound; 7 = 51-67 tails per pound; 8 = 68 and over tails per pound.

BILLING CODE 3510-22-C

The size-depth-month patterns in white shrimp catch are not as simple as those of brown shrimp, but they do reflect the annual nature of the white shrimp's life cycle. The fishery on the 0-year class white shrimp, spawned in the spring and summer, essentially begins in August and September (Fig. 3. 2–7). The white shrimp catch in internal waters contains much larger size shrimp than does the brown shrimp catch. This size difference refleots the rapid growth rate of white shrimp and their tendency to leave the estuaries at a larger size than brown shrimp. Catch remains comparatively high from August to November, though it it essentially limited to water shoreward of 11 fathoms. The comparative increase in shrimp catch in the 68 tails and over count group in October through December reflects a decline in the growth rate of white shrimp as well as a migration of shrimp to deeper waters. Both of these phenomena are associated with cold fronts advancing during these months and the accompanying decline in temperature.

Catch declines from December through February. The decline reflects, in part, adverse weather conditions for shrimping but also the dwindling supplies and comparatively small size of white shrimp during this period.

In March through June with the spring warming of the estuaries and shallow Gulf, the overwintered white shrimp are believed to exhibit an increase in their growth rates. This increase is reflected in the commercial catch: peak size classes of white shrimp shift from those greater than 67 tails to the pound to 31 to 40 tails to the pound in March to shrimp 15 to 20 tails to the pound in June and July. The May and June inshore catch of white shrimp reflects the reentry of overwintering white shrimp into the estuaries for a period of pre-spawning growth.

Catch by Size, State, and Species for Brown, White, and Pink Shrimp

Different harvesting strategies have developed among the several Gulf States. These differences largely relate to the evolution of the dominant fisheries at different times (Section 3.2.1.2). The Louisiana-Mississippi fishery developed comparatively early on inshore and nearshore Gulf concentrations of white, brown, and seabob shrimp. The brown shrimp fishery in Texas and the pink shrimp fishery in Florida developed in the 1950's on offshore concentrations of shrimp in comparatively deep water. In large part local management still reflects the needs of the historical fisheries in these areas for shrimp of certain sizes or of their gear restrictions limiting the depth of harvest.

Tables 3.2–1 and 3.2–2 compare estimates of the average commercial (1963–1976) catch of brown, white, and pink shrimp in the various reported size categories in terms of pounds and estimated number (see Table 3.2–2 for method in which number of shrimp were estimated).

Catch from the states of Mississippi and Alabama were combined due to similarities in the minimum size of harvest and overlapping areas in the reported catch statistics.

The brown shrimp catch off the Texas coast accounts for 46 percent of the total poundage and 25 percent of the number of brown shrimp caught commercially in the U.S. Gulf of Mexico. Conversely, the catch associated with Louisiana accounts for 40 percent of the poundage and 64 percent of the number of commercially caught brown shrimp. The apparent discrepancy lies in the fact that Louisiana is estimated to harvest a tremendous number of shrimp in the smallest commercial size category, some 54 percent of average total catch of brown shrimp in the Gulf. Much of these shrimp are utilized in the Louisiana canning industry. Conversely, the reported catch of brown shrimp off Texas peaks at a larger size, 31–40 tails to the pound shrimp. There are no shrimp canneries in Texas and much of this product is utilized by the fresh-frozen industry. The Mississippi-Alabama and Florida catches of brown shrimp exhibit a peak catch at 51–67 tails to the pound size category.

Louisiana has by far the largest catch of white shrimp, accounting for some 82 percent by number and 77 percent by weight of the average reported catch. As with brown shrimp, the peak in catch occurs in the smallest commercial size group, though there is a comparatively better mix of larger size shrimp than with brown shrimp. The Texas white shrimp catch peaks at a size similar to the brown shrimp catch, or 31–40 tails to the pound. Though the Florida white shrimp catch peaks at the same size class as its brown shrimp catch, the Mississippi-Alabama catch of white shrimp peaks at a larger size, 15–20 tails to the pound in terms of weight, and 31–40 tails to the pound in terms of numbers.

BILLING CODE 3510-22-M

Table 3.2-1. Average weight of brown, white, and pink shrimp by size and state[1] in thousand pounds of tails (US Dept. of Comm., 1963-1975).

Shrimp	State	Size (Tails per Pound) 68 & over	51-67	41-50	31-40	26-30	21-25	15-20	Under 15	Total
Brown	FLA	37	84	50	64	18	4	2	---	259
	ALA-MISS	1724	2223	1288	1513	784	674	467	73	8746
	LA	13598	2612	1625	2636	1256	1550	1974	520	25771
	TX	1323	2287	3398	8726	4426	5234	3506	483	29383
	GULF	16682	7206	6361	12939	6484	7462	5949	1076	64159
White	FLA	189	154	81	104	64	34	22	1	649
	ALA-MISS	74	133	164	260	220	345	379	31	1606
	LA	7220	3646	2187	3780	2212	2640	2393	516	24794
	TX	519	587	490	1212	773	793	679	135	5188
	GULF	8002	4520	2922	5356	3269	3812	3673	683	32237
Pink	FLA	1135	3199	2164	2786	1411	1245	547	27	12514
	ALA-MISS	16	79	61	46	23	16	5	1	247
	LA	1	3	3	3	1	1	---	---	12
	TX	---	---	---	3	1	1	1	---	6
	GULF	1152	3281	2228	2838	1436	1263	553	28	12779
Species Combined	GULF	25836	15007	11511	21133	11189	12537	10175	1787	109175

[1] Florida = statistical area 1-9. ALA-MISS = statistical area 10-11. Louisiana = statistical area 12-17. Texas = statistical area 18-21. See Fig. 3.2-3 for location of statistical areas.

Table 3.2-2. Estimated average number[1] of brown, white, and pink shrimp by size and state[2] in thousands of shrimp (US Dept. of Comm., 1963-1975).

Shrimp	State	Size (Tails per Pound) 68 & over	51-67	41-50	31-40	26-30	21-25	15-20	Under 15	Total
Brown	FLA	2536	4954	2253	2270	513	99	31	---	12656
	ALA-MISS	151742	131134	58618	53699	21942	15513	8174	912	441734
	LA	2189355	154116	73920	93597	35159	35640	34554	6496	2622837
	TX	89949	134949	154594	309764	123920	120393	61364	6043	1000976
	GULF	2433582	425153	289385	459330	181534	171645	104123	13451	4078203
White	FLA	12848	9089	3669	3709	1782	789	384	8	32278
	ALA-MISS	6341	7834	7461	9236	6148	7939	6636	389	51984
	LA	620918	215132	99528	134204	61933	60721	45371	6446	1244253
	TX	35298	34634	22283	43020	21638	18240	11886	1690	188689
	GULF	675405	266689	132941	190169	91501	87689	64277	8533	1517204
Pink	FLA	77200	188731	98487	98920	39497	28645	9570	343	541393
	ALA-MISS	1392	4658	2765	1628	840	371	90	11	11555
	LA	241	197	122	122	31	14	7	---	736
	TX	1	18	23	115	29	19	18	1	224
	GULF	78834	193604	101397	100785	40197	29049	9685	355	553906
Species Combined	GULF	3187821	885446	523723	750284	313232	288383	178085	22339	6149313

[1]The number of shrimp caught in each size category was estimated in the following manner:

If size equals	Then number equals pounds times
Under 15	12.5
15-20	17.5
21-25	23
26-30	28
31-40	35.5
41-50	45.5
51-67	59
68 and over in Fla or Tx	68
68 and over brown or pink shrimp Miss-Ala	88
68 and over brown or pink shrimp in La	161
68 and over white shrimp in La or Miss-Ala	86

[2]Florida = statistical area 1-9. ALA-MISS = statistical area 10-11. Louisiana = statistical area 12-17. Texas = statistical area 18-21. See Fig. 3.2-3 for location of statistical area.

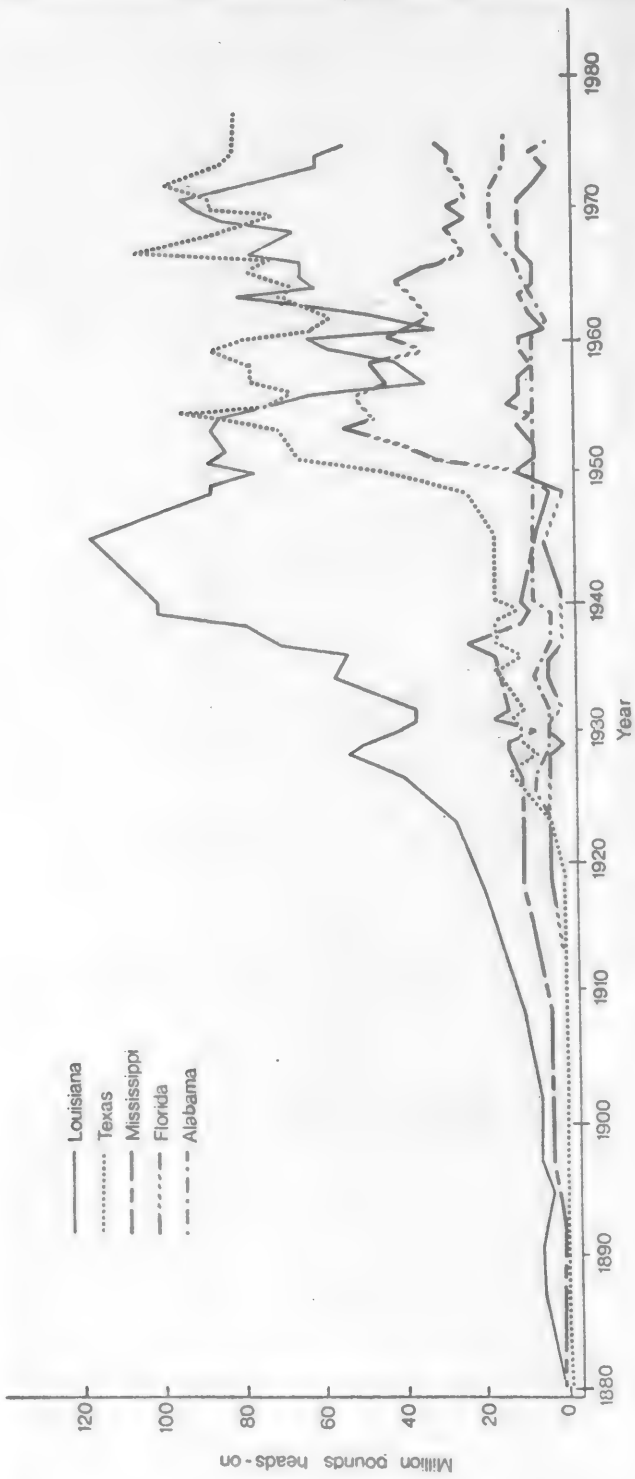


Figure 3.2-9. Annual trends in reported commercial landings of shrimp (heads-on) by Gulf state (US Dept. Com., 1880-1975). Note that landings data are for heads-on shrimp off-loaded within a state regardless of where they were caught. This graph is not directly comparable with catch data used in this report.

BILLING CODE 3510-22-C

Florida accounts for 98 percent of the pounds and numbers of pink shrimp caught in the reported commercial fishery of the U.S. Gulf of Mexico. Pounds and numbers both peak at a size of 51–67 tails to the pound.

Calliouet, et al. (in press) has noted a shift in harvest over the 1963 to 1976 period to smaller shrimp in both the Louisiana and Texas reported catch. Basic data on growth and mortality (Section 4.1) indicate a decrease in total yield in weight is expected with this shift in catch to smaller shrimp.

3.2.1.3.2 Landing Trends by State

Catch trends by species are not available before 1957. In order to provide some historical overview, Fig. 3.2–9 shows reported landings by state from 1880 to 1975. These landings data are not comparable to the catch data used in this report because they are pounds of heads-on shrimp (instead of tails) and are for shrimp landed in a state regardless of where they were caught—including foreign countries. Further, there is considerable debate as to whether the data were collected consistently over the long time span. Regardless of these questions, however, the data reflect important historical trends.

Before about 1920, Louisiana and Mississippi were the dominant shrimp producing states in the Gulf. Between 1920 and 1948 the fisheries off Texas and Alabama began to rival that of Mississippi. At the same time, Louisiana's landings far exceeded any of the other states. During these early years the fishery was mainly an inshore and shallow water fishery predominantly of white shrimp, with minor catches of seabob and brown shrimp used mainly as dried shrimp. After World War II, the fishery began to expand. Sudden increases of landings in Texas and Florida were due to the discovery of concentrations of offshore populations of brown and pink shrimp, respectively, and the successful development of markets for these species. The gradual decline in landings from Florida (west coast) after 1954 may reflect a change in landings patterns of shrimp caught in Central and South America. The dramatic decline in landings in Lousiana from 1945 to about 1961 may reflect a salinity-induced shift in estuarine production of the state from predominantly white shrimp to a mixture of brown and white shrimp. However, data are insufficient to support this hypothesis. The patterns from 1960 to 1975 reflect the mature nature of the fishery.

3.2.1.4 Description of Vessels and Gears Employed

Early Gulf coast shrimp trawlers were generally shallow-draft open skiffs ranging in length from 15 to 25 feet and powered by inboard gasoline engines. These early designs were gradually replaced in the 1920's by trawlers constructed with decks and pilot houses (Christmas and Etzold, 1977). The introduction of the diesel engine in the 1930's was considered a major advancement over gasoline engines in terms of safety, reliability, and reduced maintenance. The limited holding facilities and range of these early trawlers confined shrimping operations to areas relatively near the major shrimping ports. As a result, many coastal areas of the Gulf were inaccessible to the small trawlers (Johnson and Lindner, 1934, cited in Christmas and Etzold, 1977).

Until the late 1940's commercial shrimp landings in the Gulf of Mexico consisted primarily of white shrimp (Idyll, 1963). By the early 1950's, however, increasing quantities of brown and pink shrimp were being caught and sold in response to a growing public acceptance of these unfamiliarly pigmented species (Idyll, 1963). The strong demand for shrimp and the opening of new fishing grounds off Florida, Alabama, Texas, and Mexico initiated a period of rapid growth in the size of the shrimp fleet. The expansion of offshore fishing grounds dictated the need for larger vessels with greater horsepower capable of remaining at sea for extended periods. Innovations in design and construction, such as steel hulls and onboard freezer units, were incorporated into the newer offshore trawlers of the late 1940's (Christmas and Etzold, 1977).

Captiva (1966) stated that the modern trends in the design and construction of shrimp trawlers were: (1) the increasing use of all-welded steel construction instead of wood; (2) more powerful engines; (3) onboard installation of sorting, packaging, and freezing equipment; (4) more comfortable crew accommodations; (5) development of multipurpose vessels which may be rapidly rerigged with a variety of fishing gears; (6) modern hydraulic equipment; (7) increased use of modern electronic equipment; and (8) increased use of newer hull materials such as aluminum and fiberglass-reinforced plastics.

The shrimp boat design most commonly seen in the offshore waters of the Gulf of Mexico is believed to be a derivation of Greek designs used in the sponge fishery on the Florida west coast (Idyll, 1963). The "Florida-type" vessels are characterized by the forward placement of the wheelhouse and engine room. Current construction trends are toward larger offshore Florida-type vessels ranging from 75 to 80 feet or more in length (Christmas and Etzold, 1977).

The "Biloxi-type" vessel design, with the wheelhouse and engine room aft, is used primarily for shrimping in the inshore waters of the Gulf region (Idyll, 1963). These vessels range from 30 to 45 feet in length and are less common than the Florida-type designs (Idyll, 1963).

The boats used in inshore shrimp fisheries are made of wood or fiberglass and range in length from 16 to 50 feet. Most of the boats use gasoline-powered inboard or outboard motors for propulsion, and some may be equipped with powered winches to retrieve nets. The smaller boats are rigged in a variety of ways and are primarily confined to sheltered inshore waters. The larger boats may occasionally fish offshore if weather conditions are suitable. The "mosquito" fleet of Louisiana is made up of numerous small boats, generally operated by one person, that shrimp commercially in the inshore bays and marshes. These boats are typically shallow-draft, open skiffs.

Deep-water trawling for royal red shrimp in the Mississippi and Tortugas grounds has been steadily increasing in the past few years. Royal reds are fished by wood, steel, and aluminum vessels ranging in length from 56 to 86 feet. Most of the vessels are double-rigged and are capable of shrimping both the shallow and deep water of the Gulf. Smaller vessels and boats usually do not have the winch capacity or sufficient stability in rough seas to fish for royal reds (Klima and Ford, 1970).

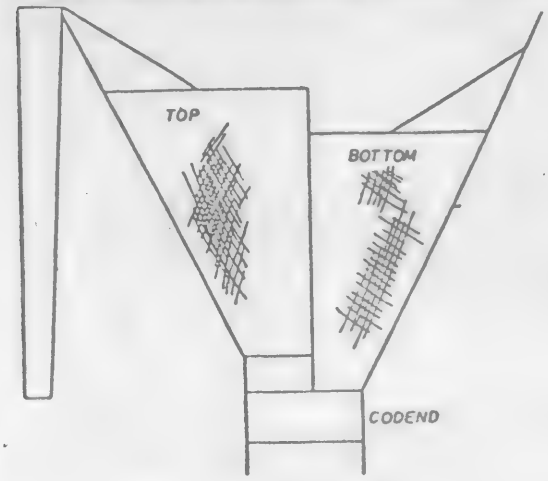
Although the otter trawl is the most common of the gears used in the Gulf shrimp fisheries, other kinds of gear are also used. The star trawl was developed for shallow-water shrimping in the Gulf of Mexico (Marinovich and Whiteleather, 1968, cited in Klima and Ford, 1970). Sideframe trawls, used almost exclusively to harvest bait shrimp on the Florida west coast from Cedar Key to Naples (Woodburn, et al., 1957; Saloman, 1965), are virtually unknown in the other Gulf states. Researchers are conducting experiments with the electric trawl, beam trawl, separator trawl, and excluder panels. Other gear types used by both commercial and recreational shrimp fishermen include haul seines, cast nets, channel nets, wing nets, and push nets.

The haul seine was the primary gear used to harest shrimp until the introduction of the otter trawl in Beaufort, North Carolina, between 1912

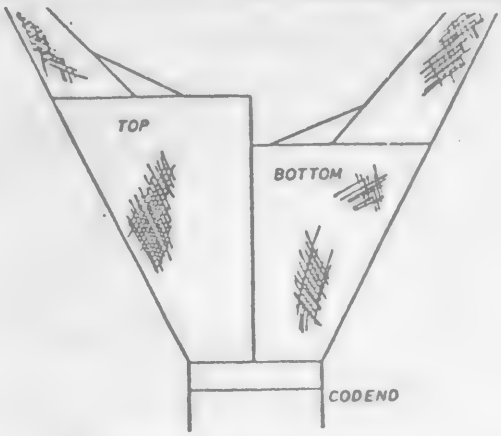
and 1917 (Christmas and Etzold, 1977). Tulian (1920) reports that the otter trawl was introduced into the Louisiana shrimp fisheries in 1917. The use of the otter trawl spread rapidly among shrimp fishermen in Louisiana because of the increase in catch per man-hour possible over haul seines.

An otter trawl consists of a a heavy mesh bag with wings on each side designed to funnel the shrimp into the codend or tail. A pair of otter boards or trawl doors positioned at the end of each wing hold the mouth of the net open by exerting a downward and outward force at towing speed.

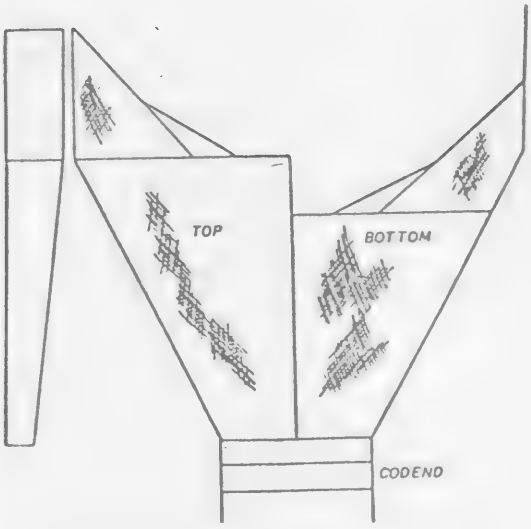
BILLING CODE 3510-22-M



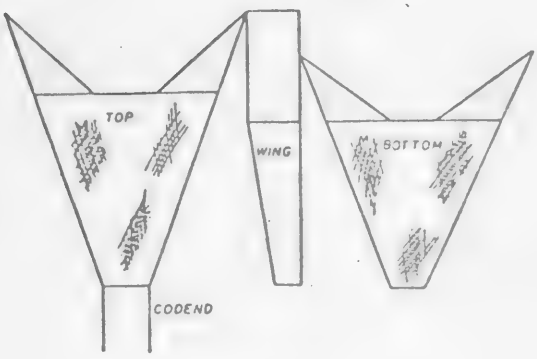
Gulf flat net



Two-seam semi-balloon trawl



Gulf four-seam semi-balloon trawl



Star net

Figure 3.2-10. Diagrams of the four basic designs of otter trawls used by the Gulf of Mexico shrimp fleet (after Christmas and Etzold 1977).

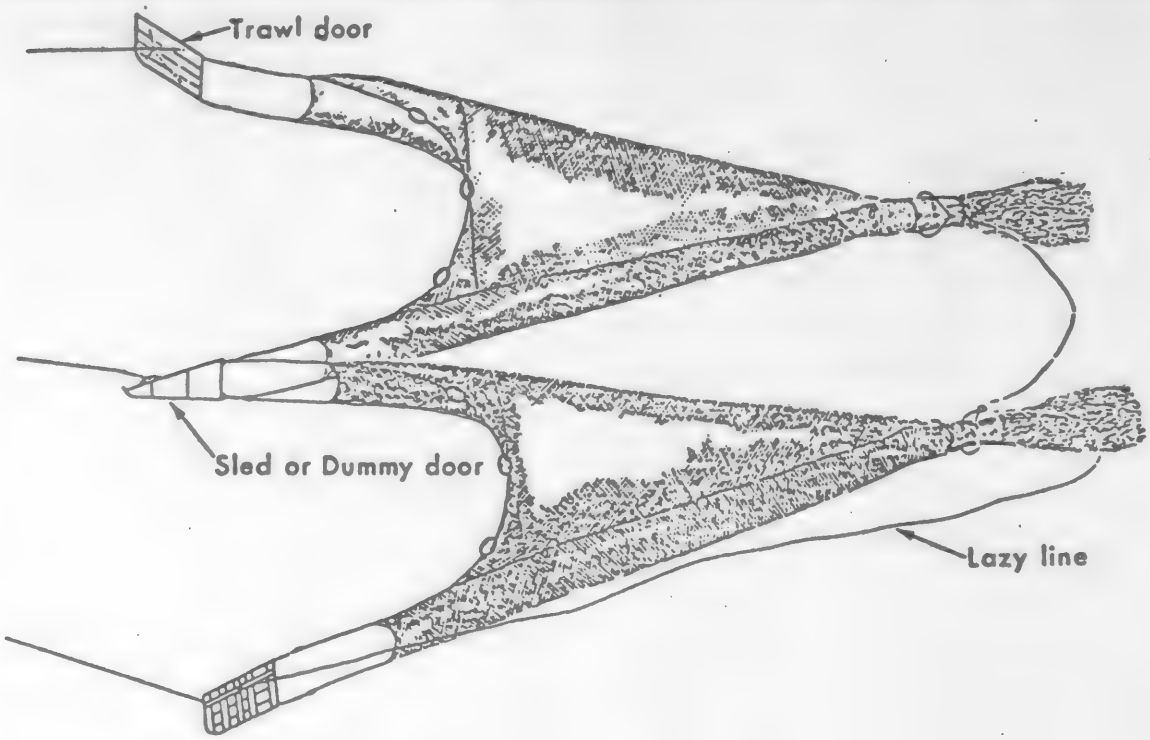


Figure 3.2-11. Diagram of the twin-trawl rig (after Harrington et al. 1972).

BILLING CODE 3510-22-C

The two basic otter trawl designs used by the Gulf shrimp fleet are the flat and the semi-balloon trawls (Klima and Ford 1970). The mouth of the flat trawl is rectangular in shape, whereas the mouth of the semi-balloon design forms a pronounced arch when in operation. The basic design of each trawl type is shown in Figure 3.2–10. The semi-balloon designs tend to maintain an efficient shape under repeated towing strains; flat nets require periodic rerigging and rehanging to maintain maximum efficiency (Christmas and Etzold, 1977). The two-seam semi-balloon trawl (Figure 3.2–10) was introduced in the Gulf of Mexico in 1947 (Marinovich and Whiteleather, 1968, cited in Christmas and Etzold, 1977). The two-seam design was followed by the development of the four-seam semi-balloon trawl, which has "a shorter jib with wings on either side between the top and bottom bellies," whereas the "top and bottom bellies were joined directly together" in the two-seam design (Christmas and Etzold, 1977). The four-seam trawl maintains an efficient shape under towing strains and therefore creates less resistance in the water than the two-seam trawl.

About 90 percent of the fishermen in the royal red fishery use 55- to 75-foot flat otter trawls, and the remainder use semi-balloon trawls ranging in width from 45 to 60 feet (Klima and Ford, 1970).

Try nets are small otter trawls about 12 to 15 feet in width which are used to test areas for shrimp concentrations. These nets are towed during regular trawling operations and lifted periodically to allow the fishermen to assess the amount of shrimp and other fish and shellfish being caught. These amounts in turn determine the length of time the large trawls will remain set.

Until the late 1950's, most shrimp vessels pulled single otter trawls ranging from 80 to 100 feet in width (Idyll, 1963). Double-rig trawling was introduced into the shrimp fleet during the late 1950's. The single large trawl was replaced by two smaller trawls, each 40 to 50 feet in width, which were towed simultaneously from stoutly constructed outriggers located on the port and starboard sides of the vessels. The port trawl was towed about 150 feet in back of the starboard trawl to prevent fouling. The advantages of double-rig trawling are (1) increased catch per unit of effort, (2) fewer handling problems with the small nets, (3) lower initial gear costs, (4) a reduction in costs associated with damage or loss of the nets, and (5) greater crew safety (Idyll, 1963).

The haul seine consists of a large rectangular panel of webbing ranging up to 1,000 feet in length and 20 feet in depth. It was mainly used before 1917. At that time mesh size ranged from 0.5- to 1.5-inch bar and a large crew was required to set and fish the net. Typically, a corkline buoyed the top of the net and a leadline was attached to the bottom edge. Haul seines were frequently constructed with bags or pockets where the captured shrimp were forced to congregate. Although the haul seine is no longer used to harvest commercial quantities of shrimp, it is still licensed in some states.

Cast nets are used mostly by sportsmen along tidal creeks, bayous, and weirs where shrimp congregate seasonally. Cast nets are circular, usually ranging from 6 to 12 feet in diameter, with a leadline sewn around the periphery of the net. A cord line passes through a metal or plastic thimble in the center of the net and radiates out to several smaller cords which are attached at even intervals to the leadline. Cast nets are usually constructed of nylon webbing with a 0.25- to 0.75- inch mesh. The nets are thrown in a circular pattern and allowed to sink to the bottom. The cord line is pulled in, causing the leadline to be drawn to the center of the net where the shrimp are trapped.

Channel nets are stationary nets which resemble otter trawls and catch emigrating shrimp in narrow cuts and bayous in areas with large tidal amplitude. The mouth of the net is held open with anchors or poles instead of trawl doors. The contents of the net are periodically dumped into a small skiff or a box located onshore.

BILLING CODE 3510-22-M

Table 3.2-3. Estimates of Foreign Catch (in tails) of Shrimp (1971-1976) in Waters Now Considered as Within the US Fishery Conservation Zone of the Gulf of Mexico (Data from Charles Fuss, NMFS, personal communication 1978).

Bordering state	Year	Foreign country involved: Estimated catch			Total estimated foreign catch
		Cuba	Mexico	Panama	
		Pounds			
Florida	1971	57,440	0	0	57,440
	1972	10,240	0	0	10,240
	1973	20,480	0	0	20,480
	1974	75,000	0		75,000
	1975	135,000	105,000	0	240,000
	1976	0	0	0	0
6-year average		49,693	17,500		67,193
Texas	1971	0	2,783,300	0	2,783,300
	1972	0	83,820	0	83,820
	1973	1,710,000	0	0	1,710,000
	1974	1,110,000	90,000	0	1,200,000
	1975	1,665,000	225,000	0	1,890,000
	1976	722,750	0	126,000	848,750
6-year average		867,958	530,353	21,000	1,419,311

Table 3.2-4. Estimates of Monthly Foreign Effort and Catch Directed Toward Shrimp (1971-1976) in Waters Now Considered as Within the US Fishery Conservation Zone of the Gulf of Mexico (Data from Charles Fuss, NMFS, personal communication 1978). Weight is tail weight.

Bordering states	Year	Principal fishing months	Estimated # vessels	Estimated fishing days per vessel	Estimated number of vessel days	Estimated catch per vessel day	Estimated total catch (pounds)
				Mexico			
Florida	1971	--	--	--	--	--	--
	1972	--	--	--	--	--	--
	1973	--	--	--	--	--	--
	1974	--	--	--	--	--	--
	1975	July	7	30	210	500	105,000
	1976	--	--	--	--	--	--
Texas	1971	June	128	16	2,048	195	
		July	345	16	5,520	418	
		August	11	16	176	435	2,783,300
	1972	June	7	16	112	435	
		July	5	16	80	[439]	83,820
	1973	--	--	--	--	--	--
	1974	July	3	30	90	500	
		October	3	30	90	500	90,000
	1975	July	8	30	240	500	
		August	7	30	210	500	225,000
	1976	--	--	--	--	--	--
				Cuba			
Florida	1971	January	10	16	160	715	
		February	6	16	96	240	57,440
	1972	February	2	16	32	320	10,240
	1973	February	4	16	64	320	20,480
	1974	January	1	30	30	500	
		November	4	30	120	500	75,000
	1975	February	3	30	90	500	
		August	6	30	180	500	135,000
	1976	--	--	--	--	--	--
Texas	1971	September	7	2	14	--	--
	1972	--	--	--	--	--	--
	1973	April	3	30	90	500	
		May	5	30	150	500	
		June	15	30	450	500	
		July	59	30	1,770	500	
		August	32	30	960	500	1,710,000
	1974	April	3	30	90	500	
		May	10	30	300	500	
		June	16	30	480	500	
		July	35	30	1,050	500	
		August	10	30	300	500	1,110,000
	1975	June	25	30	750	500	
		July	46	30	1,380	500	
		August	40	30	1,200	500	1,665,000
	1976	June	25	25	625	350	
		July	11	25	775	350	
		August	19	25	[475]	350	[656,250]
				Panama			
Florida	1971	--	--	--	--	--	--
	1972	--	--	--	--	--	--
	1973	--	--	--	--	--	--
	1974	--	--	--	--	--	--
	1975	--	--	--	--	--	--
	1976	--	--	--	--	--	--
Texas	1971	--	--	--	--	--	--
	1972	--	--	--	--	--	--
	1973	--	--	--	--	--	--
	1974	--	--	--	--	--	--
	1975	--	--	--	--	--	--
	1976	January	1	30	30	350	
		September	5	60	300	350	
		October	1	30	30	350	126,000

BILLING CODE 3510-22-C

Butterfly or wing nets are bags constructed of nylon webbing which are hung on a rectangular frame and attached to the side of a boat. Boats equipped for "butterfly" shrimping anchor themselves heading into the current and lower the nets into the water perpendicular to the gunwales. The tidal currents are then allowed to sweep emigrating shrimp into the mouth of the net. The net can be checked without raising the frame by lifting the codend on board with a lazy line and emptying the contents into a sorting box. The net is than put overboard to resume fishing while the catch is sorted.

Push nets, which are occasionally used to catch shrimp is shallow-water areas of Florida and Texas, are small mesh bags hung on rectangular frames. The operation of a push net usually involves an individual wading and pushing the net before him in shallow water.

3.2.2 History of Foreign Exploitation

3.2.2.1—3.2.2.3 General Description of User Groups, Fishing Effort, Vessels and Gear Employed

Foreign shrimp fishing in the U.S. Gulf of Mexico has been virtually nonexistent in 1977–1978 (Charles Fuss, NMFS, personal communication, 1978) as a result of the passage of the FCMA. Prior to 1971, Mexican vessels had been shrimping in U.S. waters for many years; Cubans entered the fishery in 1971, and some Panamanian boats shrimped off Texas in 1976 (Table 3.2–3). Annual harvest for the years 1971–1976 from zero to 2.8 million pounds in tails off Texas and zero to 135,000 pounds in tails off Florida. Mexican harvest off Texas ranged from zero to 2,783,000 pounds in talis. Cuban boat activities off Texas were concentrated in the months of June, July, and August, the peak brown shrimp season (Table 3.2–4). It is estimated that 30 boats worked 29 days per month and harvested 408,000 pounds in tails per month. Mexican boats, present in the same waters duing the same period, in 1971 totaled 345 and took an estimated 2.3 million pounds. The catch fell sharply in ensuing years. Cuban boat activities off Florida occurred mainly during the winter months; from one to ten vessels were involved, and the take was as high as 135,000 pounds in tails annually. Seven Mexican vessels took 105,000 pounds of shrimp tails off Florida in july 1975 (Charles Fuss, NMFS, personal communication, 1978). Foreign vessels are of the same configuration as the U.S. offshore fleet and utilize similar gear.

3.3 History of Management

3.3.1. Management Institutions, Policies, Jurisdiction

Inland water management of the Gulf shrimp fishery is based on the laws and regulations of the five states affected. All the states have restrictions on the size of shrimp which may be taken; all have exclusive state authority for the determination of shrimping seasons; all require licensing of or permits for various types of shrimp dealers and vessels; all provide for restricted waters to some degree; all have penalties for violations of law and regulations; Florida, Alabama, Mississippi, and Louisiana have some administrative authority to negotiate reciprocal shrimp agreements with other states while Texas has none. All Gulf states have agencies concerned with wetlands management; shrimp habitat protection in nursery areas comes within their purview as advisory or rule-making bodies. However, none of the states have yet a federally approved Coastal Zone Management Program which would embrace all the laws and regulations of the governing bodies, both local and state, affecting the state-controlled shrimp fishery and nursery areas. The five states all have reporting requirements, but the type of information asked for and the diligence with which it is sought vary. Louisiana, Mississippi, and Alabama are authorized to collect taxes based on volume from shrimpers and/or processors. None of the states have a limited entry law.

Alabama: The Department of Conservation and Natural Resources is responsible for shrimp fishery management. Its powers include determination of open and closed seasons, regulation of time, place, and method of taking seafood, and authority to require submission of statistical information from shrimpers and processors. Direct supervision of seafoods is handled by the Department's Division of Marine Resources; headed by a director named by the Commissioner of Conservation and Natural Resources. A thirteen-memeber advisory board meets at least twice each year to review regulations proposed by the Commissioner and to establish policy on proposed legislation. The advisory board can revise or repeal regulations proposed by the Commissioner, or it can adopt its own regulations by a two-thirds vote and the consent of the Governor. All seafood in state-owned waters is declared to be state property. Wetlands management in Alabama is under the jurisdiction of the Coastal Area Board (appointed by the Governor). Its area of authority begins at the ten-foot contour line and is concerned with habitat protection. A fourteen-member advisory committee of experts in all fields of coastal usage advises the Coastal Area Board. Alabama has entered into reciprocal shrimp agreements with Louisiana, Mississippi, and Florida.

Texas: Overall control of the Texas shrimp fishery is either vested in the six-member Parks and Wildlife Commission appointed by the Governor or controlled by the legislature. The Commission establishes rules and regulations in some coastal counties and may adjust the closed Gulf season; enforcement is handled by the Texas Parks and Wildlife Department. The Texas Shrimp Conservation Act is applicable all along the Texas coast because the Commission has adopted it as a regulatory policy. State jurisdiction extends seaward three leagues (nine nautical miles) from the coast line. The state distinguishes between inside waters—all bays, passes, rivers, or other bodies of water landward from the Gulf—and outside waters, extending from the shoreline seaward to the extent of Texas jurisdiction. The Texas Coastal Coordination Act requires the Texas Natural Resources Council to study problems and issues in connection with coastal natural resources and to submit a biennial study with recommendations for action on identified problems. The Council is also to recommend research and data acquisition priorities. Texas has no reciprocal shrimp agreement with the other Gulf states; legislative approval of any such agreement would be required. The Commission is empowered to coordinate any Texas shrimp management plans with those drafted for the federal fishery zone.

Louisiana: The Wildlife and Fisheries Commission has exclusive control over the shrimp fishery and the shrimp industry. Rules and regulations are promulgated by the seven-member Commission. Its members are named by the Governor to serve overlapping terms and represent various segments of fish- and wildlife-related industries and sportsmen's groups. Administration is handled by the Department of Wildlife and Fisheries. The Department's Office of Coastal and Marine Resources is responsible for enforcing regulations and monitoring the shrimp fishery. A severance tax, payable by the first purchaser and collected by the Department, is levied on shrimp taken from Louisiana waters. Data reporting is required from shrimp processing plants and wholesale dealers. The Department has a limited degree of authority to enter

into reciprocal agreements with other states. Louisiana's jurisdiction extends seaward three nautical miles from the coastline. The state differentiates between inside waters, including the large bays, and outside waters. Shrimping seasons are set for inside waters; there is no closed season for outside waters. Regulations proposed by the Commission are subject both to review by the Joint Senate and House Natural Resources Committee and to the Administrative Procedures Act which requires public notice through publication in the Louisiana State Register prior to ther adoption by the Commission. The State Department of Transportation and Development is in the process of developing a Coastal Zone Management Program covering coastal marshes and estuaries and extending to Louisiana's seaward boundary. The vast Louisiana shrimp nursery grounds are included in the territorial limits to be covered by the program.

Mississippi: A thirteen-member Mississippi Marine Conservation Commission has full power to manage, control, supervise, and direct all matters pertaining to saltwater aquatic life. This Commission was superseded on July 1, 1979, by the newly-created Mississippi Commission on Wildlife Conservation as part of a restructuring of Mississippi government. Executive authority is vested in the Director of Wildlife who is elected by the Commission for a four-year term. The reorganization will bring into being a Bureau of Marine Resources to be supervised by a director experienced in marine conservation; this Bureau is to aid the Commission in "formulating policies, discussing problems and considering other matters." The Commission determines seasons, restricted waters, and size of shrimp to be taken. The Commission is authorized to require such reporting as may be needed to meet the needs of any research project, and persons receiving such questionnaires are required to respond factually. Fines are imposed for failure to respond or for falsifying data. A severance tax is imposed on all shrimp processed, transported in or from the state, or caught within state waters. The state has a broadly-worded statute covering reciprocal agreements. The Mississippi Marine Resource Council is authorized to study "plans, proposals, reports, and recommendations" for development and utilization of coastal and offshore lands, waters, and marine resources.

Florida: The Florida Department of Natural Resources is the state's shrimp fishery regulating agency. It is empowered to adopt rules and regulations governing "method, manner, and equipment" used in taking shrimp and to define areas where shrimp may be caught. Its Division of Marine Resources is charged to "preserve, manage, and protect" fishery resources and to regulate vessels and fishermen "within or without" the boundaries of the state. However, the legislature has adopted numerous local laws (general bills of local application) which regulate shrimping in the particular counties. Special county acts govern shrimping seasons in Apalachicola Bay, St. Vincent Sound, and the area from Cape San Blas to Cape St. George. By legislative act, some nursery areas are permanently closed to all except bait shrimping. Florida has uniform rule-making procedures for all administrative agencies; these procedures require prior notice, an economic impact statement, and an opportunity for "substantially affected" persons to challenge proposed rules on the grounds of invalid exercise of the agency's legal authority. Proposed rules are also to be reviewed by a legislative Administrative Procedures Committee. Florida has no statute specifically taxing the taking or handling of shrimp. The Department of Natural Resources is authorized to enter into reciprocal agreements with other states, giving shrimpers based in such states the same "rights and privileges" that residents of states in which they are fishing have.

3.3.1.1 Regulatory Measures Employed to Regulate the Fishery

The following is summarized from Craig, et al. (1978).

Legal Size of Shirmp; Catch Limits

Texas: Thirty-nine to the pound, heads on, and 65 to the pound for tails, based on a three- to five-pound sample of shrimp per 1,000 pounds. Commercial shrimpers are not limited as to amount of shrimp taken in outside waters; 300 pounds per day limit in spring open season for inside waters; no limit on fall catch in major bays, however, August 15 to October 31, minimum count of 50 whole is required; no count restriction November 1 to December 15. Recreational shrimpers may take 100 pounds per day in outside waters, 15 pounds per day from major bays in spring, and 100 pounds per day in fall open season. Commercial bait shrimpers are limited to 150 pounds per day.

Louisiana: Inside waters size limit is 68 whole shrimp to the pound; limit not applicable in outside waters or to any species taken during spring inside waters open season, nor to brown shrimp taken after November 20. There are no catch limits on commercial shrimpers; unlicensed recreational shrimpers are limited to 100 pounds per boat per day. Bait shrimp are excluded from size requirements.

Mississippi: Size limit is 68 whole shrimp to the pound. Bait shrimpers are not subject to size limitation. No catch limits.

Alabama: Size limit is 68 whole shrimp to the pound. Bait shrimp are excepted. There are no catch limits for commercial including bait shrimpers. Recreational boats are limited to 25 pounds per boat in areas open to commercial shrimpers and 15 pounds per boat in bait shrimping areas.

Florida: Statewide size limit is 47 to the pound, heads on, and 70 tails to the pound; in three panhandle counties local size limit is 55 to the pound, heads on, in open inside bays and sounds. No catch limits.

Licensing of Vessels and Fishermen

Texas: Commercial Gulf shrimp boat, bay shrimp boat, bait shrimp boat, and sport shrimp trawl must be licensed; "John Doe" licenses are also required for the captain and each crewman of commercial vessel and a personal license for each recreational shrimper.

Lousiana: Commercial boat license based on length; no license needed for recreational boats; license required for all gear except noncommercial under 16 feet in length.

Mississippi: Vessel license is based on length; bait shrimp boats and interstate vessels pay additional annual fees. No shrimp gear license required.

Alabama: Vessel license for Alabama residents and non-resident shrimpers required unless there is reciprocal agreement with state of their residence; gear license is based on length of trawl.

Florida: Vessels are registered according to size; permits are required for trawling but no charge is assessed. Alien and nonresident commercial fishermen are required to obtain license.

Season

Texas: Inside waters in major bays are open May 15 to July 15 and August 15 to December 15. Outside waters are normally closed June 1 to July 15, subject to 15-day alteration in opening and closing. White shrimp may be caught during the closed season at zero to four fathoms during the day. Outside waters are also closed December 16 to February 1. During the closed season seabobs may be harvested during the day, but catch can contain no more than ten percent of other species. Zero to seven fathoms at night closed year round.

Louisiana: For inside waters, the spring season opens no later than May

25 and continues for at least 50 days or until technical data indicate a closure is needed to protect newly recruited white shrimp; however, at least one zone must have a 50-day open season. Fall season opens the third Monday in August and closes December 21. Commission may set special seasons. No closed season in outside waters.

Mississippi: The season opens first Wednesday in June, dependent on shrimp size of sample catch, and usually runs from the second or third week of June until following April 30 unless declared otherwise.

Alabama: Closed from late April to mid-June, depending on samples.

Florida: Season varies according to area.

Restricted Waters

Texas: All passes to and from outside waters are closed to trawling. Shrimping in inside waters is limited to major bays and bait bays as defined by law. Other inside waters are classified as nursery areas and no shrimping is allowed.

Louisiana: State and federal wildlife refuges, Bayou Judge Perez, and sanctuaries in Lake Pontchartrain and Lake Catherine are restricted waters.

Mississippi: Commercial shrimping is forbidden within one-half mile of mainland from Mississippi-Alabama line west to Bayou Caddy, off Gulf Island National Seashore, and in all bayous with the exception of two pipeline ditches in Hancock County.

Alabama: All rivers, streams, bayous, creeks, and portions of bays designated as nursery areas are restricted. No shrimping is allowed within 200 yards of the beach off Dauphin Island and Mobile Point from May 5 to September 15.

Florida: Portions of Santa Rosa Sound, Tortugas shrimp bed in Florida waters, and that portion of the Tortugas shrimp bed in the FCZ are closed to Florida residents. Other areas are subject to local seasonal restrictions. Certain areas designated as state parks or recreational areas are closed to commercial fishing.

3.3.1.2 Consistency Requirements of Coastal Zone Management Act

Consistency provisions of the Coastal Zone Management Act require a Council, in preparation of a fishery management plan, to address and consider the extent of fishing within State waters, on the premise that good management principles "require that the FMP address an individual stock of fish as a unit throughout its range, including its presence within state waters." Councils should "make every effort to coordinate their FMP development activities with the state coastal zone agencies."

3.3.2 Management and Regulation of Foreign Fishery

The present extent of the U.S. fishery conservation zone in the Gulf of Mexico is defined on the basis of two treaties on maritime boundaries, one with Mexico and the other with Cuba. Both treaties are now pending Senate advice and consent to ratification. In the meantime, the maritime boundaries specified in the treaties are being applied provisionally.

Access to the FCZ for foreign shrimp fishermen must be predicated on an available surplus of shrimp in excess of the U.S. harvesting capacity, as well as a Governing International Fishery Agreement (GIFA) with their home country. Likewise, for U.S. shrimp fishermen to gain access to the zones of exclusive fisheries jurisdiction of Mexico or Cuba, there must be a surplus over the harvesting capacity of the domestic fishermen involved. Cuba has a GIFA with the United States effective September 26, 1977, and Mexico a GIFA effective December 28, 1977. However, the FCMA does not permit allocations to the fishermen of either country unless a shrimp surplus is determined.

For the past three years the U.S.-Mexico Fisheries Agreement has authorized U.S. fishermen to fish for shrimp within Mexico's fishery zone, but the Agreement allows for no further access after 1979. The United States has therefore initiated negotiations with Mexico in an effort to obtain some form of continued shrimp access. U.S. fishermen have no access to fish for shrimp in the Cuban fishery zone. The U.S.-Cuba Convention for the Conservation of Shrimp was terminated on April 28, 1978, after being in force twenty years.

3.4 History of Research

Other than the work of Percy Viosca and various annual reports by the Gulf states, little was recorded about Gulf shrimp until the 1930's. During the 1930's, the various Gulf states and the U.S. Bureau of Commercial Fisheries initiated a series of intensive studies on the life history of white shrimp (Lindner and Anderson, 1956). These mark-recapture and associated studies provided the basis for our knowledge of Gulf shrimp as well as providing a model for subsequent studies and an initial group of fishery scientists knowledgeable about Gulf shrimp and their environment.

The history of research since that time is too extensive and diverse to summarize in this section. Indeed, this entire plan attempts to summarize only that portion of the research which is directly relevant to the mandates of FCMA.

No articles were encountered which would indicate studies on U.S. Gulf shrimp had been supported by foreign countries.

3.5 Socioeconomic Characterization

3.5.1 Output of the Subject Domestic Reported Commercial Fishery

Measured by the value of shrimp at dockside, the shrimp fishery is the most valuable of all domestic fisheries, averaging 23 percent of the value of all fish landed in the United States for the period 1964 through 1977. Translated into dollars, the 1977 fish and shellfish landings were worth $1,515,000,000. Shrimp accounted for $355,200,000; salmon, $221,900,000; and tuna, $135,800,000.

The Gulf of Mexico commercial shrimp fishery accounted for 83 percent of the dockside value of the U.S. shrimp landings and in terms of pounds of shrimp, the relative Gulf contribution is 67 percent of the U.S. landings.

3.5.1.1 Ex-vessel Value of the Catch

Table 3.5–1 gives the ex-vessel or dockside value of all shrimp species reported in the Gulf states from 1958 through 1977. These figures are for landings and do not reflect the actual areas where shrimp were taken (shrimp caught off the coast of one state, or another country, may be landed in another state). The Gulf-wide average annual increase in value of shrimp landed was 8.9 percent.

Texas, with an average of 46 percent of the value of all landings, has consistently had the largest ex-vessel value of all the Gulf states. Louisiana accounts for 28 percent of the average annual value of the landings. Florida ranks third at 15 percent of the total value.

The pronounced increase in dockside values between 1974 and 1977 is primarily the result of significant increases in price—from $1.17 in 1974 to $1.66 in 1975, a high of $2.08 in 1976, and $1.78 in 1977. Poundage figures for the years were: 117 million pounds of tails in 1974, a drop to 107 million in 1975, 132 million in 1976, and up to 166 million pounds (tails) for 1977.

The main factors cited for the recent increase in total value (1974–1977) of the landings are (1) the recovery of domestic demand for shrimp products, (2) world demand, (3) decreases in the supply of U.S. imports, (4) general inflation, (5) domestic inventory reductions after 1974–1975 (due to U.S. and world demand), and (6) increased landings.

Area Distribution of the Value of the Catch

Fig. 3.5–1 compares the average value distribution of the combined brown, white and pink shrimp catches from 1959 to 1975. Area 19 (the Freeport, Texas, grid) has the highest ex-vessel value. It has accounted for an average of 19 percent of the total value. Waters adjacent to Texas provide 42 percent of the average shrimp catch value. The value of the catch off Louisiana accounts for 36 percent of the total value; Florida, 11 percent; and Alabama and Mississippi each six percent.

A comparison of the value of landings (Table 3.5–1) and the average percent of the value of catch (Fig. 3.5–1) indicates some apparent differences, for example, Texas and Florida have larger percentage values in landings (see above) than are accounted for in percentage value of catch, whereas Mississippi and Louisiana have smaller values in landings than expected from the reported value of the catch. These differences reflect the mobility of much of the Gulf fleet. For example, until recently many vessels from Florida and Texas, because of their proximity, had shrimped off Mexico and landed a portion of their catch in the United States. Some vessels from Florida often migrate north in the spring and summer to fish off Mississippi and Louisiana and then Texas. Vessels from Louisiana frequent the shallow waters off Galveston, Texas, fishing for white and brown shrimp. Texas boats may fish off Louisiana during the Texas closed season in June and part of July. Alabama's Bayou La Batre vessels have the capability to "roam" the Gulf in search of shrimp, though they are larger than the average sized vessel in the northern Gulf.

BILLING CODE 3510-22-M

Table 3.5-1
EXVESSEL VALUE OF
SHRIMP LANDINGS BY STATE

(In thousands of $)

	Florida West Coast	Alabama	Mississippi	Louisiana	Texas	Total Gulf
1958	$16,312	$1,984	$2,377	$13,533	$29,665	$63,871
1959	9,752	1,991	2,345	13,067	23,193	50,348
1960	12,155	2,090	2,899	15,881	24,606	57,631
1961	11,094	1,154	1,281	8,913	21,208	43,650
1962	14,556	1,647	2,220	14,985	27,149	60,557
1963	12,256	2,419	2,484	19,789	26,591	63,539
1964	13,322	2,630	1,805	18,794	26,144	62,695
1965	13,905	3,654	2,523	19,584	31,241	70,907
1966	12,427	4,920	2,751	24,390	38,485	82,973
1967	10,476	6,049	3,122	24,573	46,355	90,575
1968	12,695	7,964	3,677	25,623	45,870	95,829
1969	12,021	8,788	4,011	33,358	42,884	101,062
1970	13,108	8,040	3,810	34,614	48,614	108,186
1971	12,985	11,451	4,362	43,285	64,191	136,274
1972	17,309	14,661	4,966	47,066	80,099	164,101
1973	22,601	14,165	3,698	44,511	86,879	171,854
1974	21,445	13,490	3,225	32,203	67,679	138,042
1975	27,799	17,843	3,825	40,968	87,902	178,337
1976	36,842	30,393	8,418	79,688	119,881	275,222
1977	39,971	33,487	10,113	87,183	125,620	296,374
Average Annual % Change	5.2%	16.6%	6.5%	9.5%	9.1%	8.9%

From Fishery Statistics of the United States.

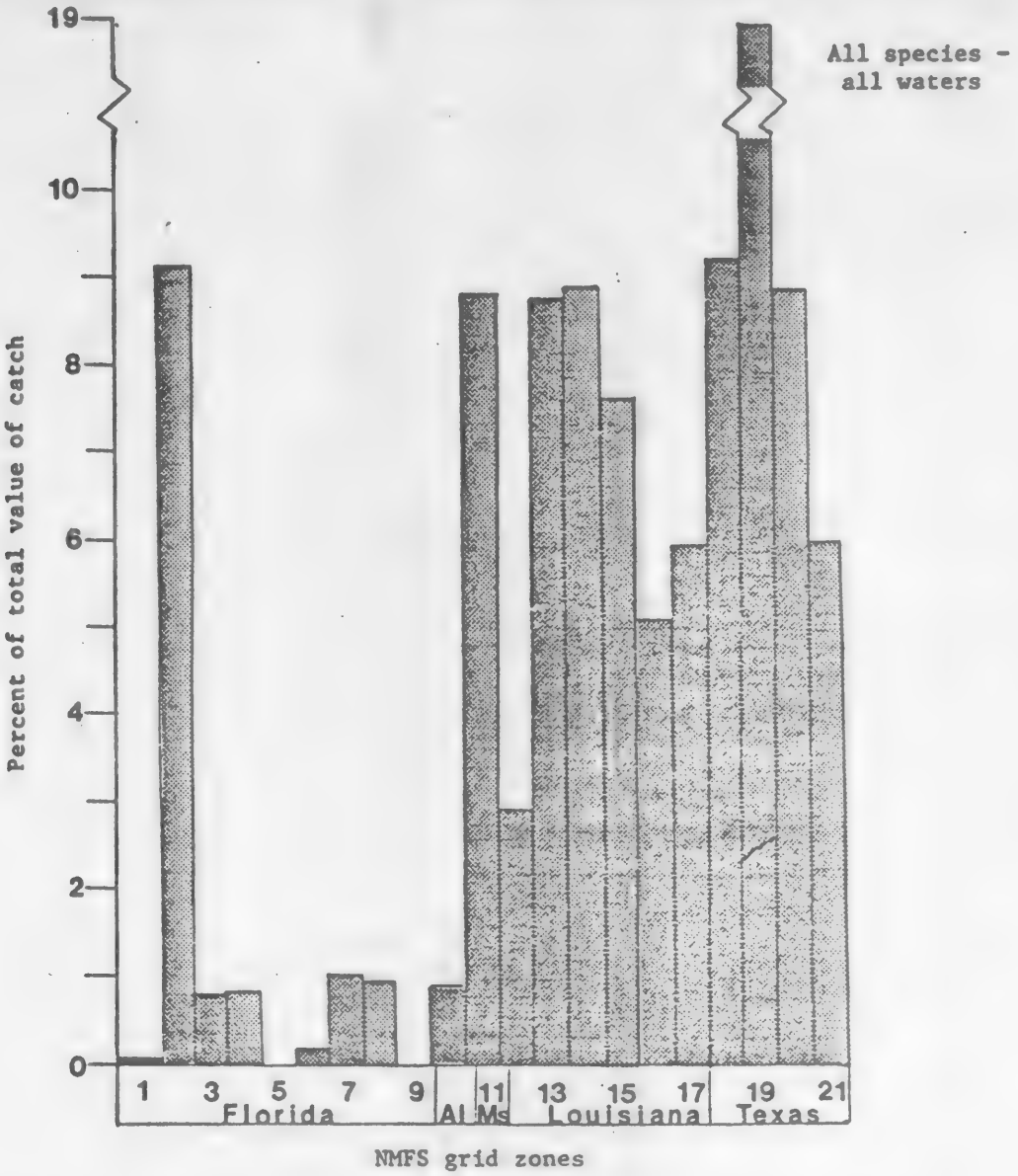


Figure 3.5-1. Average percent of total value of the Gulf catch for all species 1959-1975 by area (US Dept. Com., 1959-1975).

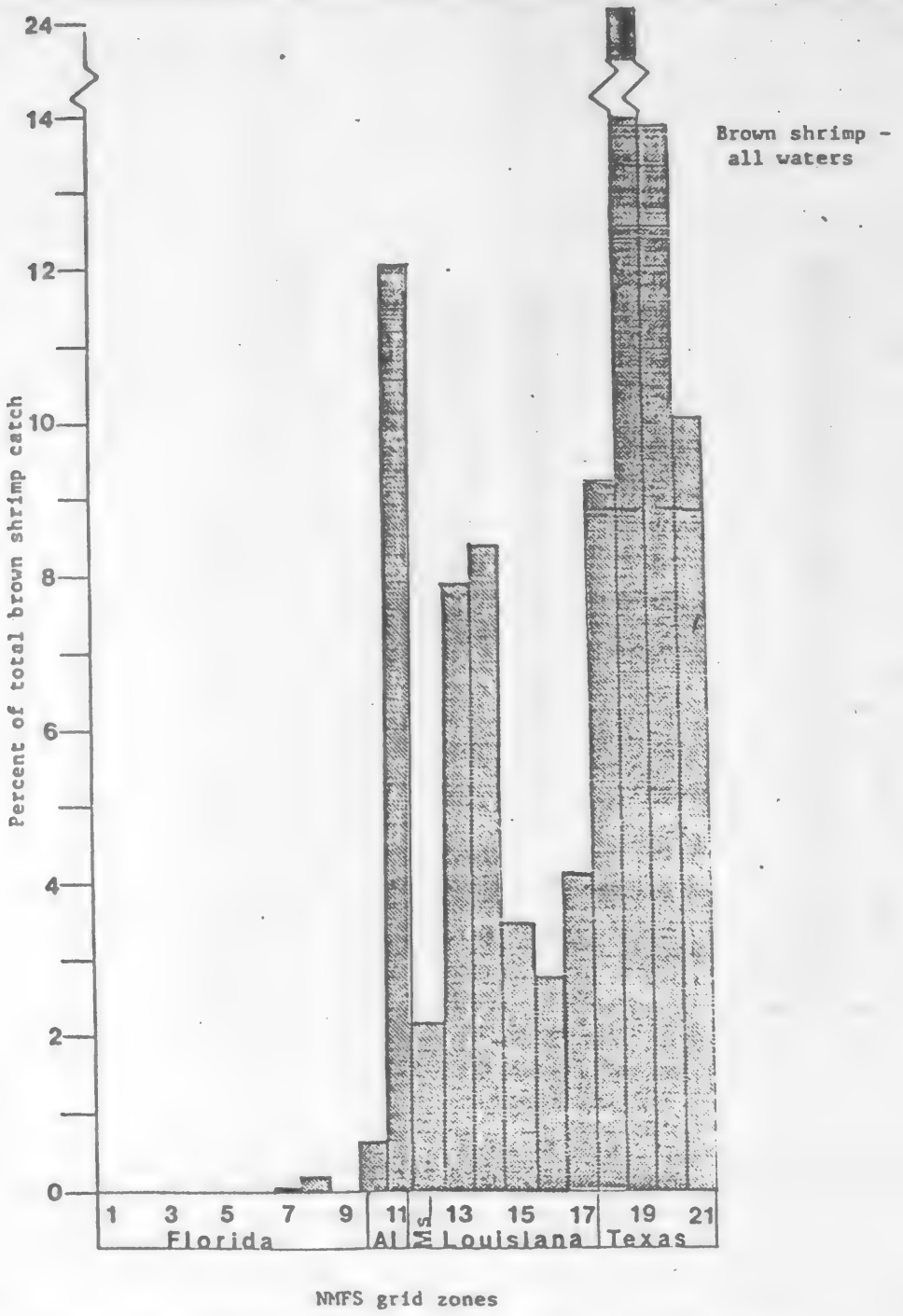


Figure 3.5-2. Average percent o the total value of the brown shrimp catch 1959-1975 by area (US Dept. Com., 1959-1975).

BILLING CODE 3510-22-C

Studies now underway may pinpoint current casual evidence of mobility; there have been recent reports of movement into Gulf waters by the south Atlantic fleet, especially during periods of low production in the south Atlantic states.

Harvesting regimes exert a substantial influence on ex-vessel value. Texas regulations, for example, result in much greater landings of larger-sized shrimp than do those of Louisiana. A 1958–1975 study showed Texas prices for brown shrimp to be 1.6 times that of Louisiana brown shrimp, and 1.2 times that of white shrimp (Caillouet and Patella, 1978).

Although there have been variations in the relative importance of the ex-vessel value of brown, white, and pink shrimp, the brown shrimp is the most valuable, accounting for 52 percent of the total value of all species from 1958 to 1967 and for 56 percent of the total value from 1968 to 1977. White shrimp are the second most valuable species. The relative position of white shrimp increased from 25 percent of the total value in the 1958–1967 period to 30 percent of the total value during the 1968–1977 period. The percentage of total value of Gulf shrimp catch attributable to pink shrimp has fallen from 21 percent in the 1958–1967 period to 13 percent for 1968–1977.

Approximately 57 percent of the annual value of the brown shrimp catch is from Texas, 28 percent from Louisiana, and the remaining 15 percent from Mississippi, Alabama, and Florida (Fig. 3.5–2).

Louisiana, waters furnish 61 percent of the value of the white shrimp harvest, Texas 30 percent, Mississippi five percent, Alabama three percent, and Florida one percent (Fig. 3.5–3).

The Florida catch accounts for 97 percent of the total pink shrimp value (Fig. 3.5–4). The Dry Tortugas area accounts for 70 percent of this value. Seabob are concentrated in the Atchafalalya River area of Louisiana (Fig. 3.5–5). These waters furnish 92 percent of the value of the catch. Texas adds four percent and the remainder comes from areas east of the mouth of the Mississippi (Fig. 3.5–5). Florida accounts for 98 percent of the rock shrimp ex-vessel value (Fig. 3.5–6). The royal red fishery is concentrated in two areas (Fig. 3.5–7): the Dry Tortugas catch is 45 percent of the total value, while the catch off the Mississippi delta is 42 percent of the value.

Price Structure Sensitivity to Size Distribution of the Catch

The price per pound for shrimp varies in direct proportion to size. There are significant price differences between size groups of shrimp. Price differentials play a key role in the substitution of certain sizes for others into various products such as breaded shrimp, fresh-frozen, and specialty items. This price structure appears to be partially sensitive to changes in the size distribution of the catch (Toevs and Johnson, 1978).

3.5.1.2 Wholesale Value of the Product

Table 3.5–2 gives the wholesale prices of shrimp in various processed forms for the Gulf of Mexico fishery for 1958–76. Prices for all categories have fluctuated frequently, but on the average, they have increased at a rate of 4.0 to 7.5 percent per year between 1958 and 1976. Prices of breaded, cooked, and otherwise processed shrimp increased at smaller rates than raw shrimp input prices.

The wholesale value of processed shrimp for the Gulf states (Table 3.5–3) was 529 milliom dollars in 1977.

A diagram of the 1976 breakdown of product categories by value is shown in Fig. 3.5–8 and Figure 3.5–9.

BILLING CODE [illegible]

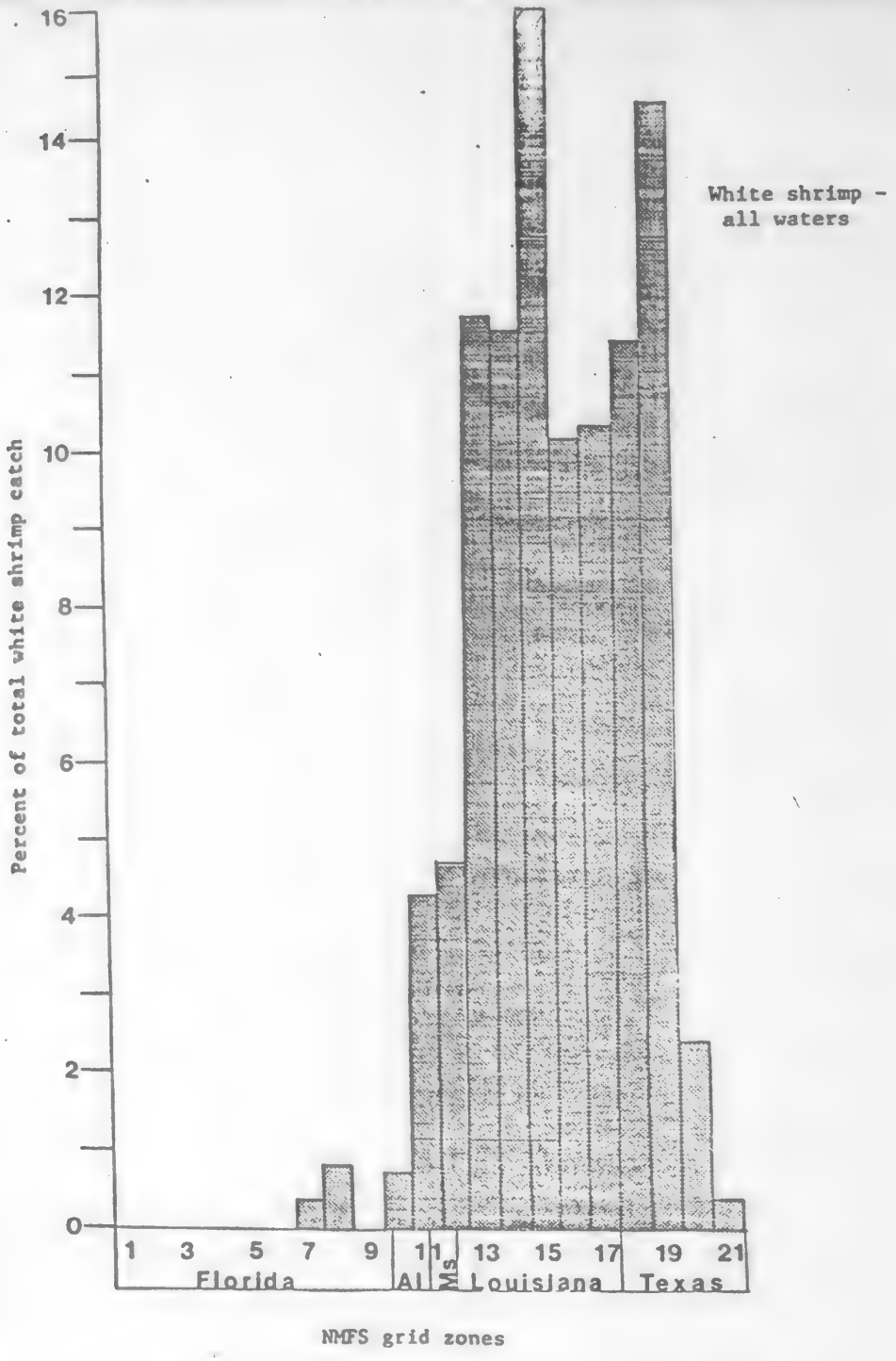


Figure 3.5-3. Average percent of the total value of the white shrimp catch 1959-1975 by area (US Dept. Com., 1959-1975).

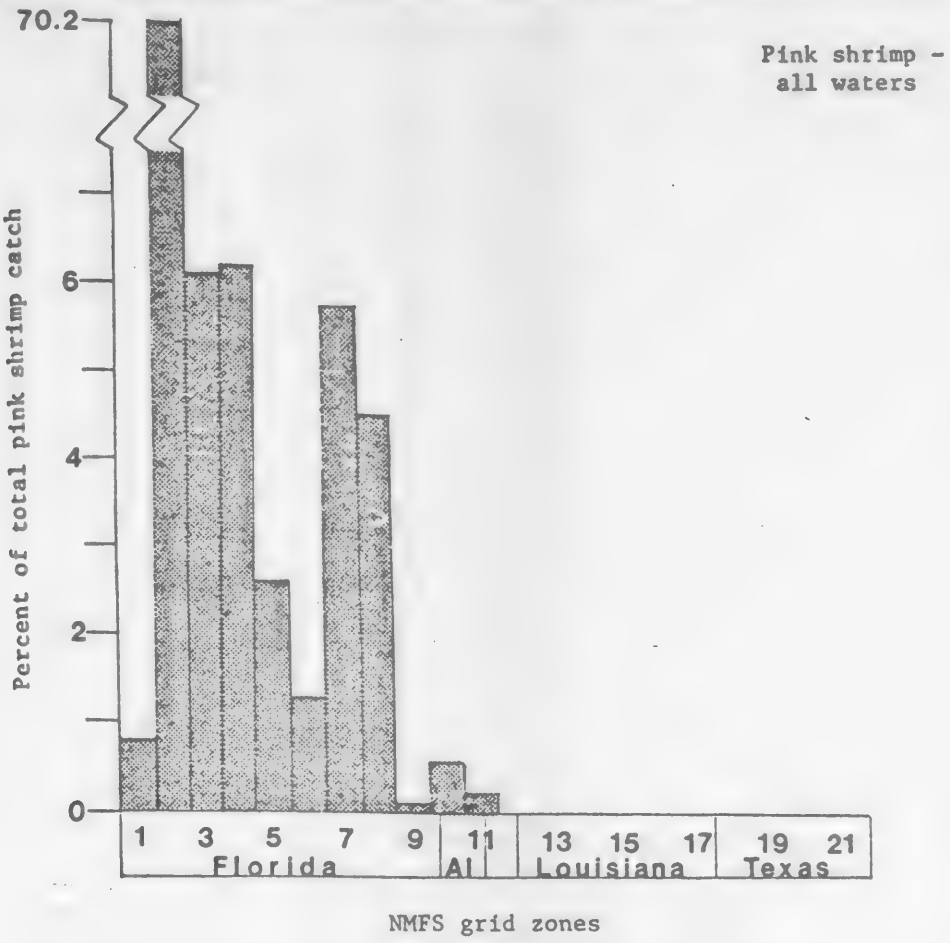


Figure 3.5-4. Average percent of the total value of the pink shrimp catch 1959-1975 by area (US Dept. Com., 1959-1975).

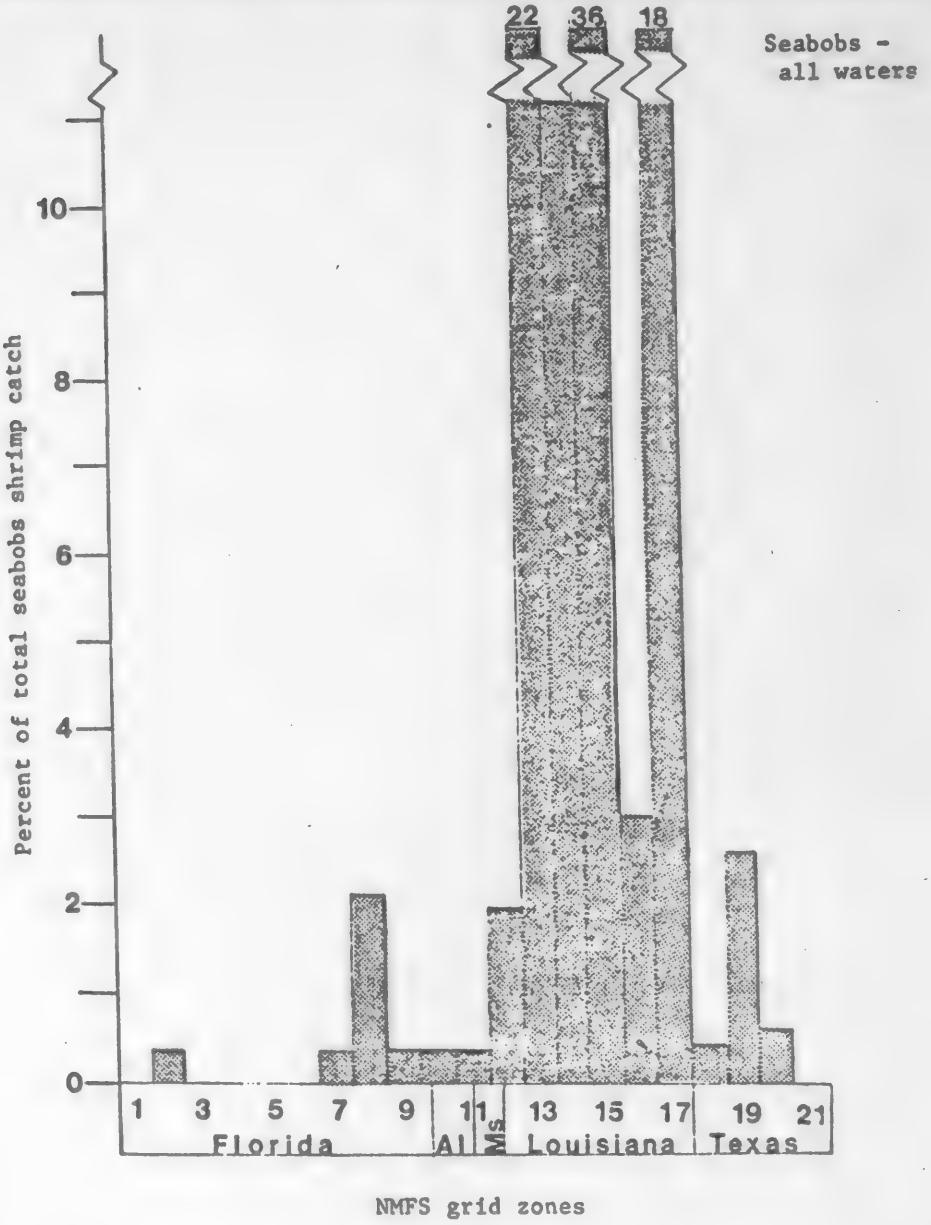


Figure 3.5-5. Average percent of the total value of the seabob shrimp catch 1963-1975 by area (US Dept. Com., 1963-1975).

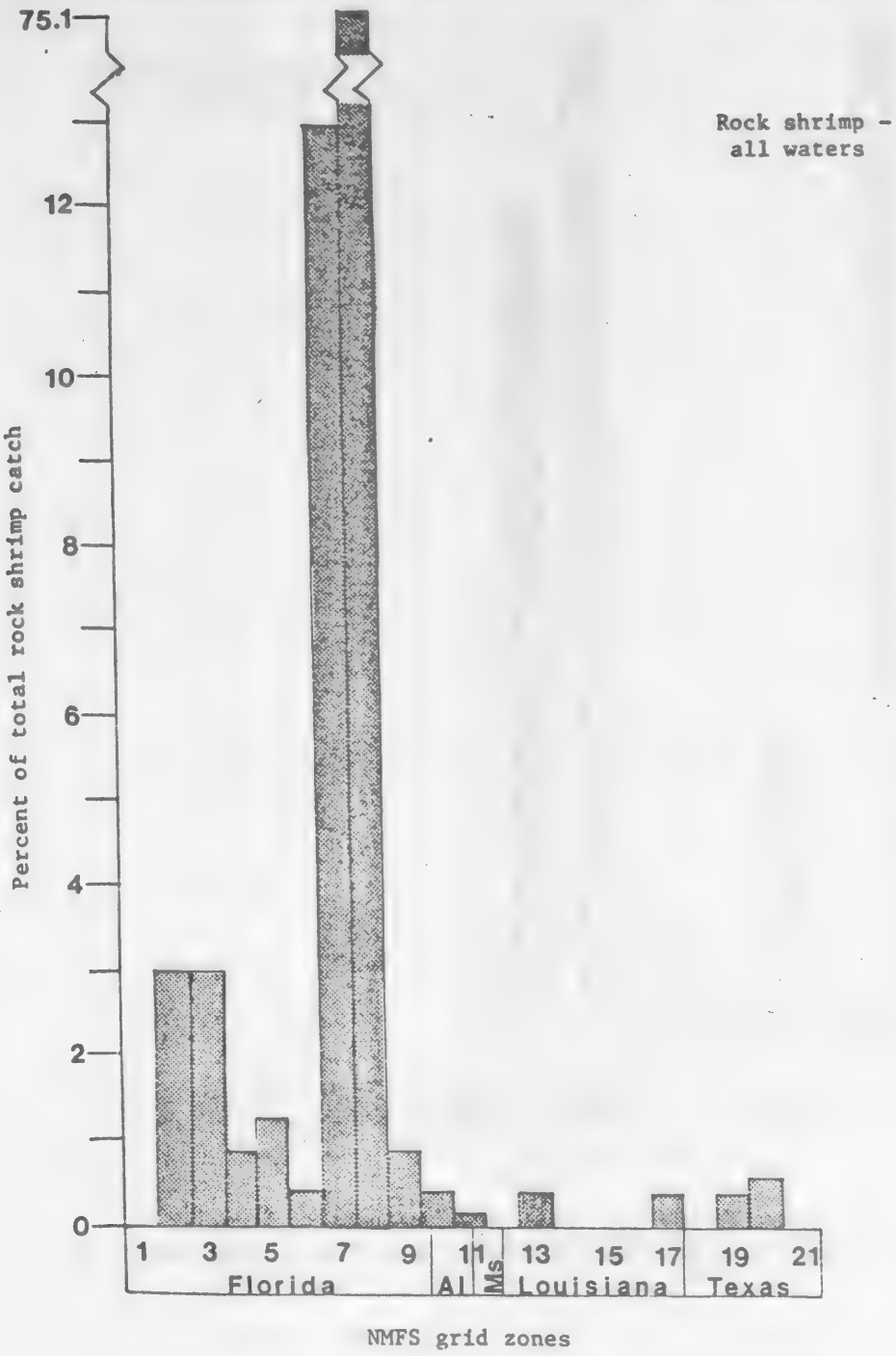


Figure 3.5-6. Average percent of the total value of the rock shrimp catch 1963-1975 by area (US Dept. Com., 1963-1975).

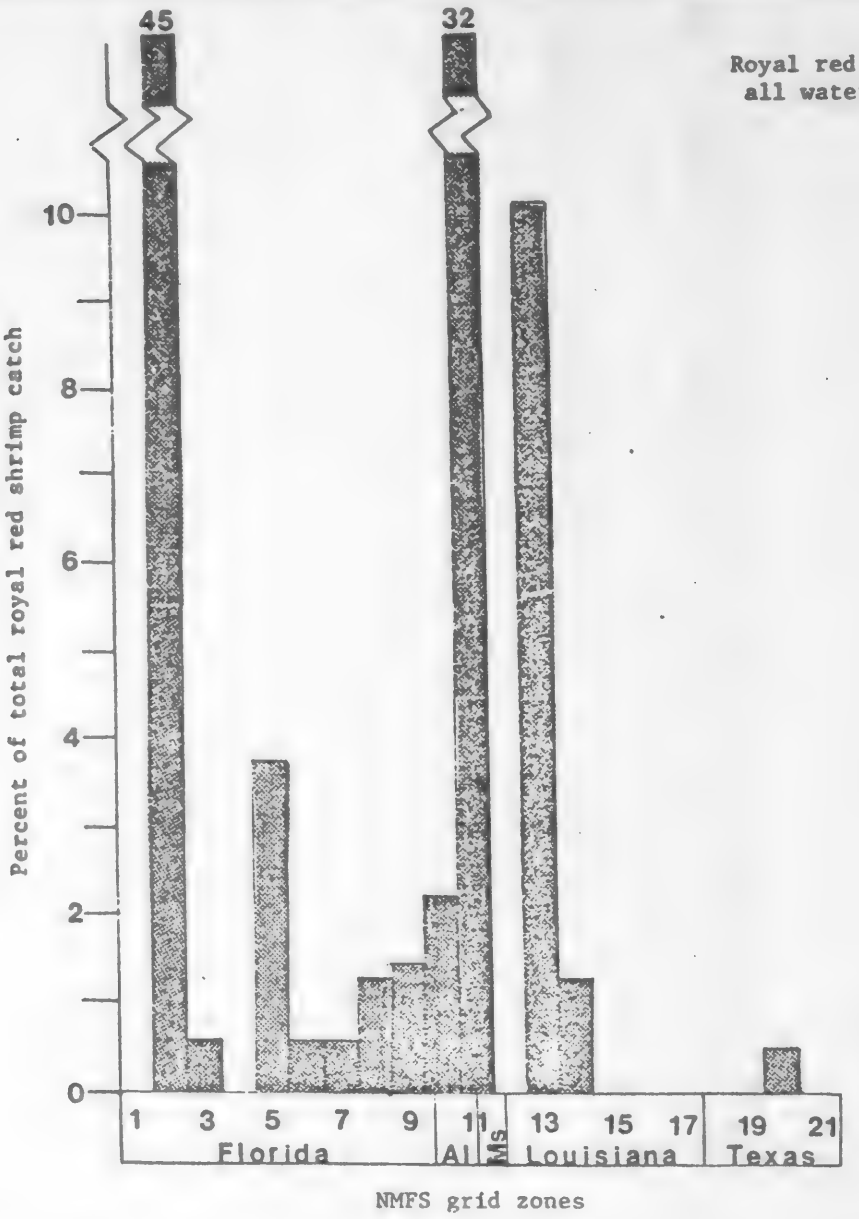


Figure 3.5-7. Average percent of the total value of the royal red shrimp catch 1963-1975 by area (US Dept. Com., 1963-1975).

BILLING CODE 3510-22-C

Processors in the Gulf are becoming increasingly dependent on shrimp imported from outside the region. Between 1958 and 1967, the average Gulf-wide shrimp landings consituted 84.2 percent of production requirements. During the 1968–1976 time period, the Guld shrimp landings declined to 73.1 percent of production requirements while total production has increased. (Fishery Statistics of the United States, U.S. Department of Commerce, various years.)

The shortage of locally landed shrimp is most pronounced on the west coast of Florida. Between 1968 and 1976, shrimp landings in this area were only 39 percent of total usage by processors. Mississippi has had a roughly similar experience with 49 percent of total processed pounds being locally supplied. The remaining Gulf states have not had to depend as heavily on non-local sources. Louisiana fishing ports have recently been able to supply more than 85 percent of the state processors' raw supply needs; in Texas and Alabama the percentages are 90 and 80, respectively. The relative sizes of the supply deficits have varied considerably for the individual years in all states.

3.5.1.3 Domestic Marketing Channels

The marketing of shrimp from the vessels to consumer may be handled through a variety of channels with as many as 11 components (Figure 3.5–10). The usual participation is more limited, however, involving fishermen, wholesalers, processors, transporters, and retailers. Other seafood product are usually handled by members of the shrimp marketing system.

Since shrimp may range from five to more than 200 tails per pound, size is the principal factor influencing market channels and use. Larger size shrimp usually go the restaurants; those in the 30 to 65 per pound range go principally to breaders, fresh seafood retailers, canners, and other processors. Smaller shrimp are use by canners, driers, and specialty producers. In recent years there has been a growing trend to use the full range of shrimp sizes for breaded, peeled, and stove-ready products.

Variation in use of marketing channels depends on many factors: shrimp size, processed form, location of processor, degree of industry concentration, source of raw shrimp, amount of imported shrimp used, and amount of foreign labor involved in processing. Area differences prevent extrapolation of the Alvarez, et al. (1976) study of Florida's marketing channels to the entire Gulf coast (Christmas and Etzold, 1977). A telephone survey of shrimp processors and middlemen in each of the Gulf states was conducted in the drafting of this plan. The survey revealed a general pattern of marketing channels, shown in Fig. 3.5–10. The bold lines in the figure indicate major channels.

Dealers

The dealer is the first middleman to take possession of the shrimp. He normally operates docking facilities with allied provisions for service and storage. His relationship with the fisherman is that of purchaser of shrimp and, on occasion, purveyor of fuel, ice, and supplies. But he may also offer financial services ranging from credit extension to maintenance of records for boats based at his dock. In this relationship there is usually an understanding that the shrimper's catch will be handled by the dealer; such a relationship may have a corrolary price impact.

Louisiana dealers surveyed reported purchasing shrimp on a regular basis from 80 to 120 craft, with the median about 110. Dealers may also get shrimp from other craft on a part-time basis; some operate craft of their own.

Among the dealer's functions are processing of shrimp for the market—heading, grading, packing, refrigerating, and storing. Some, especially in Louisiana, have operations for handling of heads-on shrimp for drying. The drying operations reduce loss of shrimp due to spoilage and permit the utilization of shrimp in periods of peak landings.

BILLING CODE 3510-22-M

Table 3.5-2

WHOLESALE PRICES OF GULF SHRIMP PROCESSED PRODUCTS

1958-1976

	Raw Headless *	Raw Peeled *	Breaded Raw *	Cooked and Peeled *	Canned **	Dried *
1958	.76	1.06	.67	1.89	10.38	1.41
1959	.59	.82	.62	1.54	8.89	.90
1960	.61	.98	.63	1.64	8.29	1.12
1961	.76	1.09	.75	1.63	9.09	1.78
1962	.92	1.24	.81	1.93	10.43	1.61
1963	.72	1.18	.71	1.77	8.59	.84
1964	.80	1.12	.71	1.61	9.14	2.04
1965	.83	1.16	.80	1.67	9.63	1.99
1966	.96	1.32	.90	1.97	10.66	2.02
1967	.88	1.37	.85	1.92	10.21	1.65
1968	1.03	1.55	.94	2.39	10.92	1.90
1969	1.09	1.75	1.00	2.04	10.29	1.74
1970	1.04	1.45	.99	1.57	10.51	no data
1971	1.28	1.69	1.07	2.51	11.14	1.87
1972	1.44	1.90	1.24	1.95	13.28	2.42
1973	2.42	2.25	1.48	3.44	18.91	3.87
1974	1.74	1.80	1.44	3.11	16.25	2.72
1975	2.35	1.77	1.61	3.36	16.74	4.92
1976	2.79	2.67	2.02	3.82	19.74	3.81
Average % increase	7.5%	5.0%	5.7%	4.1%	4.0%	6.7%

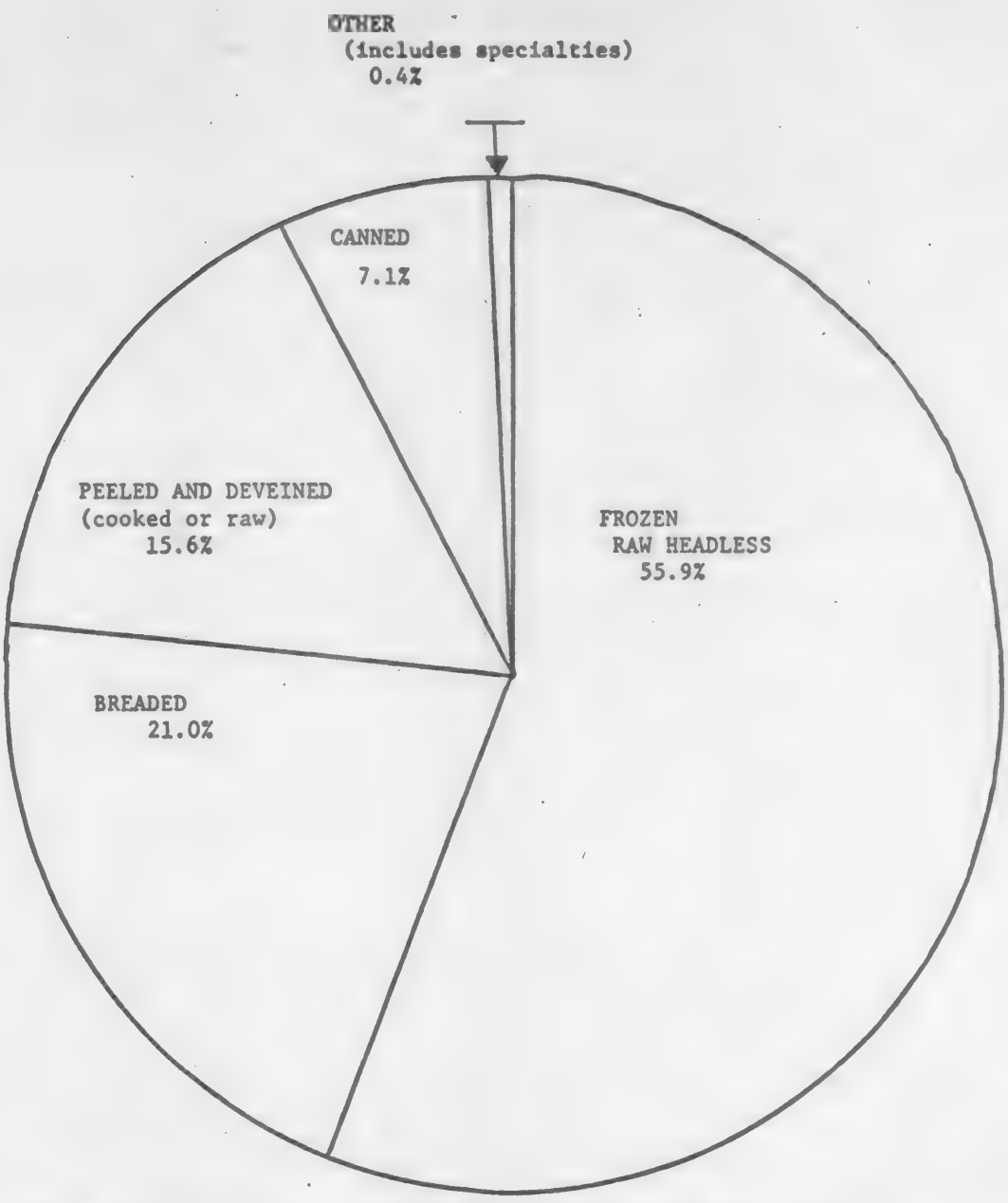
* Price per pound of finished product.

** Price per standard case of canned shrimp

From Fishery Statistics of the United States and Current Fishery Statistics

Figure 3.5-8

Value of Shrimp Products of the Gulf States, 1976



NOTE: Some of the products have been processed from raw products imported from other states or from foreign countries.

SOURCE: National Marine Fisheries Service, Processed Fishery Products, Annual Summary, 1976 (Washington D.C.: Dept. of Commerce).

Table 3.5-3

Wholesale Values of Processed Shrimp for the Gulf States
(millions of dollars)

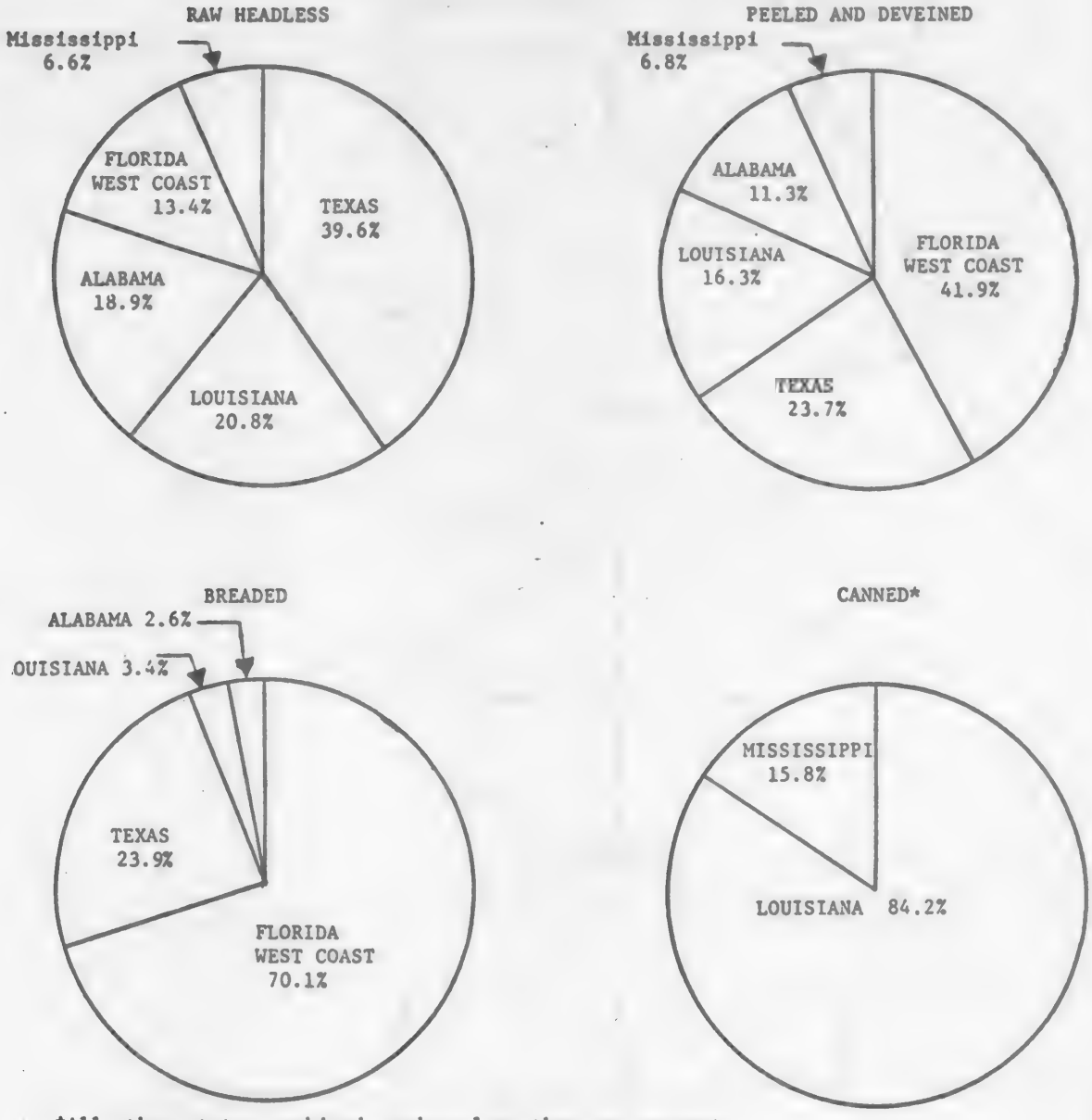
STATE	1971	1972	1973	1974	1975	1976	1977
Florida, W.C.	70.2	70.9	80.0	69.5	83.3	133.2	150.9
Alabama	11.6	23.2	30.7	20.3	28.9	59.0	68.3
Mississippi	12.7	13.7	15.7	16.9	15.7	26.9	40.0
Louisiana	65.7	64.8	76.9	72.4	64.1	95.6	125.4
Texas	93.6	110.2	120.6	80.7	67.7	141.4	144.2
Gulf Total	253.7	282.6	330.0	259.9	259.8	456.1	528.9

Numbers do not add due to rounding. Totals are correct.

From National Marine Fisheries Service, Processed Fishery Products Annual Summary (Washington D.C.: Dept. of Commerce, various years).

Figure 3.5-9
Percentage Production, by States, of
the Major Gulf Shrimp Products

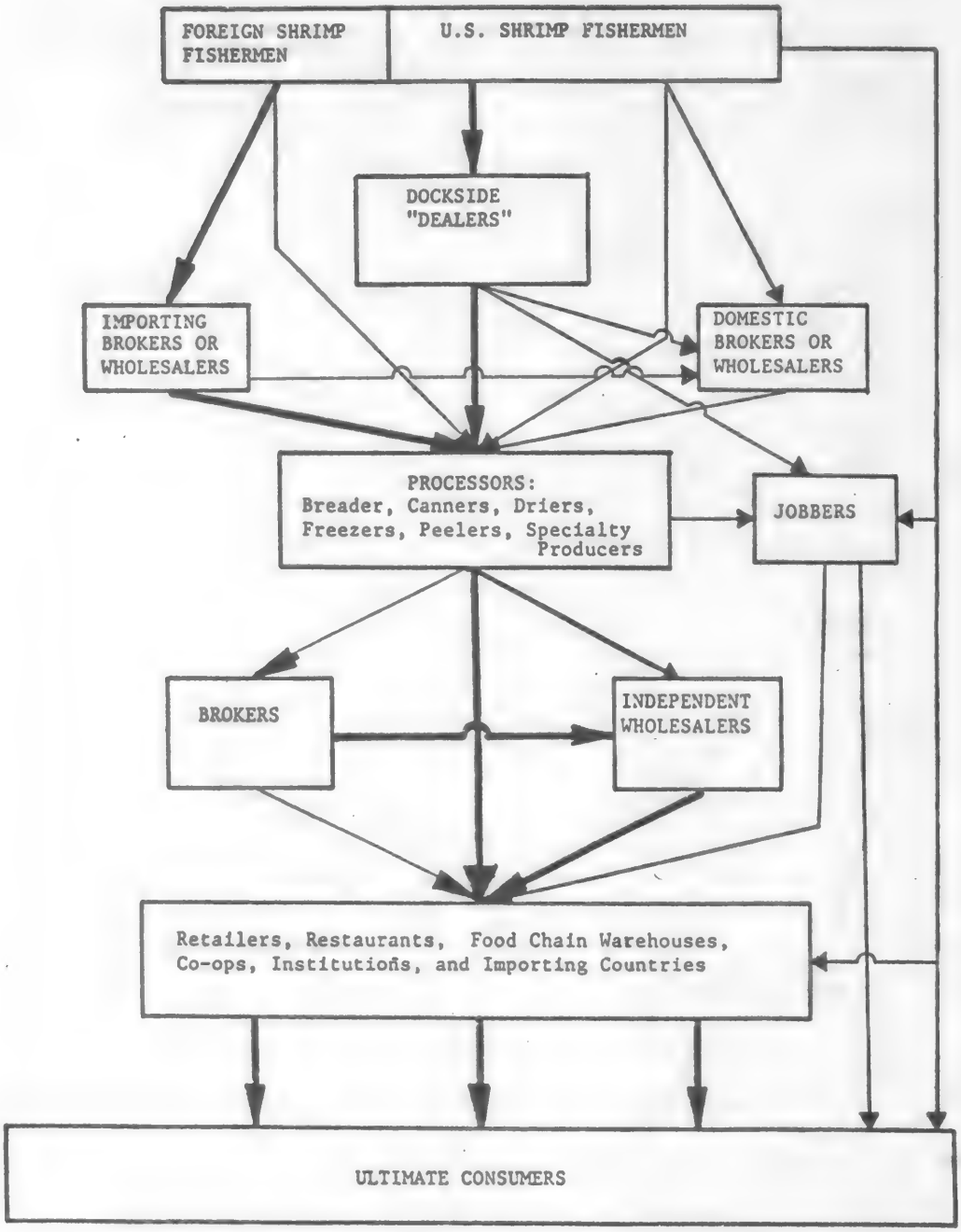
(Percentage figures based on wholesale dollar values)



*All other states combined produce less than one percent.

SOURCE: National Marine Fisheries Service, Processed Fishery Products, Annual Summary, 1976 (Washington D.C.: Dept. of Commerce)

Figure 3.5-10
Major Marketing Channels for Shrimp Products



BILLING CODE 3510-22-C

Dealer operations tend to be seasonal in nature. At peak periods the work force is augmented largely by women, teenagers, and members of the fishermen's families. The workweek can vary from three to seven days, and the working day can last from six to fifteen hours.

Most of the dealer's output is sold directly to processors; wholesalers also figure largely in this market. Dealers generally have up to 10 major customers and ship their output in their own trucks or with common carriers.

Processors

Processors are the shrimp companies engaged in peeling and deveining, cooking, freezing, canning, breading, and preparing specialty products. Some also deal in green, headless shrimp, requiring no processing.

In the southeast region, including the south Atlantic and the Gulf of Mexico shrimp fisheries, 69 percent of the processors are single facility corporation; 25 percent are either corporations with branches or divisions of parent corporations. Nearly half of the individual corporations are family owned; six percent of all southeastern processors are partnership operations.

The shrimp handling and processing industry is expanding in total volume, but the rate of withdrawal of individual firms exceeds the rate of new entrants. A shortage of domestic landings appears to put a severe constraint on the entrance of new firms and the expansion of existing ones. Major factors contributing to the shrimp shortage are: (1) The decline in U.S. landings of shrimp caught in Central South American waters. and (2) the current exploitation of the major domestic Gulf stocks at their MSY levels. An example of the decline in U.S. landings from foreign waters is Florida's landings of Campeche shrimp, which have declined from a high of more than 30 million pounds in 1953 to two to three million pounds annually (1970–1975).

There are an increasing number of processors who maintain their own fleets or dockside facilities. Others continue to depend on dealers for their shrimp supplies. Due to the seasonal nature of the shrimp catch, processors carry large raw product and frozen finished product inventories. Unlike dealers, processors tend to operate their plants throughout the year. Market forms of processed shrimp include breaded, frozen, canned and specialty products (dried, pastes, sauces, and convenience dishes).

Brokers and Wholesalers

Brokers act as an intermediary between the buyers and sellers of shrimp products at the various marketing levels, usually from the various marketing levels, usually from the processor level on up. The biggest use of brokers is in interstate and international contracts and sales, promotion of new products, and establishment of business contacts for new firms.

Wholesalers also act as intermediaries in the marketing system. They take possession of shrimp products and provide storage and transportation functions for firms in the industry, thereby creating benefits and economies for all firms.

Marketing

Channels used to market processed shrimp products vary firm to firm. Some processors have their own distribution channels—such as an organization of sales representatives or a subsidiary seller—while many other firms almost exclusively employ brokers to sell their products. Though net flows cannot be given, most processors do not limit their geographic marketing territories as much as dealers do; indeed, most processors sell on a national or at least regional basis, and many of them export shrimp, primarily to Canada, Mexico, and Japan. Tables 3.5–4 through 3.5–6 provides data on U.S. exports for 1977. Data on exports by Gulf processors are unavailable.

BILLING CODE 3510-22-M

Table 3.5-4
United States Exports of Domestic and Foreign Shrimp Products (Fishery Statistics of the United States, 1977)

Item	Percent of Total		Quantity	
	Pounds	Dollars	Thousand Pounds	Thousand Dollars
Fresh and frozen:				
Domestic	74.6%	69.5%	26,089	$60,731
Foreign*	25.4	30.5	8,902	26,643
Total	100.0	100.0	34,991	87,374
Canned:				
Domestic	99.5	99.2	8,966	18,066
Foreign*	0.5	0.8	48	144
Total	100.0	100.0	9,014	18,210
Total:				
Domestic	79.7	74.6	35,055	78,797
Foreign*	20.3	25.4	8,950	26,787
Total	100.0%	100.0%	44,005	$105,584

Table 3.5-5
Exports of Domestic Fresh and Frozen Shrimp, By Country of Destination (Fishery Statistics of the United States, 1977)

Country	Percent of Total		Quantity	
	Pounds	Dollars	Thousand Pounds	Thousand Dollars
Canada	33.1%	33.9%	8,634	$20,610
Mexico	33.8	31.3	8,811	19,003
Japan	18.1	19.7	4,718	11,957
Sweden	6.6	6.3	1,734	3,815
United Kingdom	2.4	2.4	630	1,474
Denmark	1.6	1.6	428	941
Bermuda	0.4	0.7	115	412
New Zealand	0.7	0.6	176	363
Netherlands	0.5	0.5	124	312
Other	2.8	3.0	719	1,844
Total	100.0%	100.0%	26,089	$60,731

*Foreign shrimp exports are shrimp exported out of the United States that were of foreign origin prior to processing.

Table 3.5-6
Exports of Domestic Canned Shrimp, by Country of Destination, 1974

Country	Percent of Total		Quantity	
	pounds	dollars	Thousand pounds	Thousand dollars
Canada	70.7%	72.4%	6,340	$13,076
Sweden	5.5	6.7	493	1,205
United Kingdom . . .	6.0	4.7	542	845
Switzerland.	3.3	3.2	293	582
Australia.	4.1	3.0	368	536
Japan.	3.9	2.9	345	526
France	1.9	2.3	169	417
New Zealand.	0.9	0.8	82	151
Other.	3.7	4.0	334	728
Total	100.0%	100.0%	8,966	$18,066

From National Marine Fisheries Service, Fisheries of the United States, 1977, (Washington, D.C.: US Department of Commerce, April 1978).

BILLING CODE 3510-22-C

Domestic per capita consumption of shrimp has increased at a rate of 2.8 percent per year (1960–1977), a remarkable increase given that shrimp prices increased by 600 percent while the Consumer Price Index increased by slightly more than 100 percent. Exceptions to this general increase in shrimp consumption are associated with a slowing in the growth of the U.S. economy (1961–1962, 1966, late 1973–1974) or with extraordinarily high increases in shrimp prices (1971, 1975). In addition, the energy crisis in 1974 was a factor in reducing important consumption in restaurants.

Shrimp is becoming a larger portion of the total seafood products consumed in the nation (1960–1977). A large part of this relative increase has come within the last few years despite a faster growing price for shrimp than for other processed fish products.

The socioeconomic characteristics of domestic consumers of shrimp were assessed in 1969 (U.S. Department of Commerce, 1973). An update of this data is necessary in order to evaluate what effect, if any, management of shrimp decisions may have on different types of consumers.

Pricing of Shrimp

A limited insight into the mechanism of shrimp pricing was obtained from a telephone survey (conducted in development of the plan) of processors and dealers. Shrimpers feel prices are established by dealers; dealers suggest prices are set by processors from current key port trends.

Prices seem to reflect supply and demand conditions in general and the economic strengths of the U.S. and Japanese markets in particular. Since both are large importers of shrimp, any change in the quantities imported by either country can substantially influence price.

The quantity of shrimp demanded, in a normal good year, varies inversely with price (Gillespie, et al., 1969; Bell, 1970; Doll, 1972). This suggests that management measures to increase the supply of domestic shrimp would decrease the price to consumers, all other factors being equal. Conversely, measures which would result in a decline in U.S. production would increase the cost to consumers.

The consumption of shrimp also increases as income increases (Bell, 1970; Doll, 1972). Dependence of consumption on income reflects the general dependence of shrimp prices on the economic well-being of the nation.

3.5.2 Domestic Commercial Fleet Characteristics

3.5.2.1 Total Gross income of the Fleet

Reported annual pounds and ex-vessel value for domestic catch of U.S. Gulf shrimp by vessels and by boats is compared in Table 3.5–7. Annual total income for both vessels and boats increased over this time period 1962–1974.

A 10.3 percent average annual growth rate in gross income of shrimp vessels is due to a 2.3 percent average annual growth rate in pounds of shrimp landed, plus an 8.0 percent increase in ex-vessel price. A ten percent growth rate in gross income to shrimp boats is due to a 3.2 percent increase in pounds caught and a 6.8 percent increase in ex-vessel price.

Some incidentally-caught finfish are also marketed, but the value of these marketed fish is small in comparison with that of shrimp (Figs. 3.6–1 through 3.6–5).

BILLING CODE 3510-22-M

Table 3.5-7. Reported annual pounds and value of the domestic catch of US Gulf Shrimp by boats and by vessels, 1962-1974 (Christmas and Etzold 1977).

Vessel Fishery

Year	Million Pounds (Heads-off)	Value (Million $)	Price Per Pound ($)	Total Days Fished (1000)	Effort (1000)	Pounds Per Day Fished
1962	45.4	33.4	0.74	88.5	144.0	513
1963	77.0	41.5	0.54	112.9	181.8	682
1964	71.0	40.7	0.57	114.4	186.3	621
1965	80.1	49.1	0.61	113.7	187.6	704
1966	78.3	61.9	0.79	187.6	190.5	688
1967	99.7	68.5	0.69	116.0	201.7	859
1968	83.7	68.4	0.82	121.5	218.1	688
1969	82.4	74.3	0.90	147.8	273.6	557
1970	96.1	81.4	0.85	134.6	249.1	713
1971	91.3	100.8	1.10	137.0	259.0	566
1972	94.3	120.1	1.27	146.8	282.6	642
1973	71.0	118.6	1.67	140.0	269.7	507
1974	73.9	99.8	1.35	132.4	243.6	558

Boat Fishery

Year	Million Pounds (Heads-off)	Value (Million $)	Price Per Pound ($)	Total Days Fished (1000)	Pounds Per Day Fished
1962	25.2	11.9	0.47	58.0	434
1963	33.3	9.4	0.28	38.5	865
1964	23.5	9.6	0.41	55.4	424
1965	25.5	9.5	0.37	56.7	450
1966	24.6	12.2	0.50	62.2	395
1967	30.6	12.1	0.40	66.1	463
1968	29.9	13.2	0.44	70.0	427
1969	35.5	17.8	0.50	52.6	675
1970	40.1	17.6	0.44	65.4	613
1971	42.5	23.7	0.56	67.9	626
1972	37.7	27.5	0.73	82.1	459
1973	33.6	34.3	1.02	98.0	343
1974	33.0	22.7	0.69	90.3	363

From The Shrimp Fishery of the Gulf of Mexico United States: A Regional Management Plan, J.Y. Christmas and D.J. Etzold et al.

Table 3.5-8 Annual estimates of vessels and boats in the U.S. Gulf shrimp fishery

Year	Number of Gulf Shrimping Vessels*	Gross Tons Per Vessel	Otter Trawls Per Vessel	Number of Gulf Shrimping Boats
1960	2,941	41.3	1.76	3,089
1961	2,686	42.6	1.80	2,987
1962	2,600	41.9	1.77	3,927
1963	2,697	41.5	1.76	4,481
1964	2,782	42.0	1.74	4,360
1965	2,849	42.7	1.72	4,785
1966	2,942	44.9	1.74	4,797
1967	3,146	48.9	1.76	4,983
1968	3,430	52.5	1.77	5,109
1969	3,569	53.7	1.76	4,817
1970	3,579	53.8	1.73	4,495
1971	3,487	57.8	1.77	4,828
1972	3,683	59.2	2.20	4,500
1973	4,091	59.9	1.78	4,723
1974	3,785	61.5	1.77	4,589
1975	3,690	59.5	1.78	5,054

* This total is exclusive of duplication.

From NMFS data from Fishery Statistics of the United States.

Table 3.5-9. Cost of new US Gulf shrimp vessels by various sizes and types of construction, 1971-1977 (from Warren and Griffin 1978).

Year	Vessel Length and Type		Cost
1971:	53-65'	wood and steel	$ 57,000
	66-72'	wood and steel	76,000
1973:	63-69'	wood	93,000
	63-69'	steel	118,000
	70-78'	steel	144,000
1975:	68'	wood	121,000
	73'	wood	134,000
	68'	steel	148,000
	73'	steel	185,000
1977:	68'	wood	147,000
	73'	wood	164,000
	68'	steel	195,000
	73'	steel	220,000

Table 3.5-10

Annual Participation in the Subject Fishery by Vessels and Boats (Fishery Statistics of the United States)

Year	Vessels	Days* fished per vessel	Boats	Days fished per boat
1962	2600	34.0	3927	14.8
1963	2697	41.9	4481	8.6
1964	2782	41.1	4360	12.7
1965	2849	39.9	4785	11.8
1966	2942	38.6	4797	13.0
1967	3146	36.9	4983	13.3
1968	3430	35.4	5109	13.7
1969	3569	41.8	4817	10.9
1970	3579	37.6	4495	14.5
1971	3487	39.3	4828	14.1
1972	3683	39.9	4500	18.2
1973	4091	34.2	4723	20.7
1974	3785	35.0	4589	19.7

* Day = 24 hours of fishing time

BILLING CODE 3510-22-C

Estimates of Net Income of Vessels

Net income estimates for 50–90 foot vessels varies considerably from year to year. The variation reflects a difference in annual production of shrimp (due largely to changes in environmental forces), a variation in ex-vessel value (due largely to conditions of U.S. and Japanese economy), and the limited usefulness of shrimp vessels in other economic endeavors.

3.5.2.2 Investment in Vessels, Boats, and Gear

Table 3.5–8 lists estimates of the number of vessels and boats in the domestic shrimp fleet, as well as estimated gross tons and otter trawls per vessel. These estimates indicate that since 1970 Gulf shrimp vessels have averaged 76 percent of the number and 83 percent of the gross tonnage of total U.S. shrimp vessels. The average gross tons per vessel in the Gulf is half again as large as that in the south Atlantic fleet. Since 1970 Gulf shrimp boats have averaged 83 percent of the total number of U.S. shrimp boats. The Gulf vessels are comparatively new: in 1975, 23 percent of the vessels had been constructed within the 1970–1975 period and 52 percent in the 1965–1975 decade.

Investment in vessels and gear is only available for limited portion of the vessel component of the fleet (Table 3.5–9, from Warren and Griffin, 1978). As indicated, the cost of a vessel has jumped sharply during the 1970's. Inflation, the trend to larger vessels, and additional equipment are the principal causes of the increase; and obviously a larger income is now required to justify investment in the vessels.

The 15-year trend in vessel sizes shows a decline in the relative share of the fleet in the 20 to 79 ton range, with, however, a statistically significant increase for craft larger that 79 tons. This statistic may reflect the larger vessel's ability to fish in inclement weather, its increased range, and its attractiveness to more competent crew members. There are no current studies over a sufficiently long period of time to investigate economic profitability by size of vessel. Nor have these studies attempted to examine the boat component of the fleet.

Investment in new vessels appears to be cyclical in nature: several consecutive good shrimping years induce a major increase in new craft construction and several consecutive bad years result in a pronounced reduction.

3.5.2.3 Consideration of Overcapitalization

Biological literature dealing with fishery management is replete with discussion of 'overfishing'. The economics profession has developed a similar body of literature which attributes the eventuality of this overfishing to the common property nature of fishery resources. Economic literature also identifies economic waste as an inherent aspect of harvesting common property fishery resources. Essentially, the scientific argument is that free access to fishery resources results in harvests larger that maximum economic yield (MEY) and almost centainly larger than MSY, and inefficiency employing resources for these harvests. Bromley (1969) has also pointed out the inappropriateness of applying the conventional fisheries' economic model (developed for demersal fishery) to all fishery resources.

Focusing on the economic impact of free access, then, involves deliberation over the quantities harvested and the effort and capital expended. Much debate normally occurs when proponents of MEY management argue that not only less effort but also lower harvests will be beneficial to fishermen, processors, and society at large. As Gulland (1972) indicates, shrimp fisheries exhibit flat-topped yield curves. The implication is that reductions in fishing effort are likely to result in proportionally smaller decrease in shrimp landings. Thus management of fishing effort at some point below MSY must be concerned with the benefits and costs of reducing fishing effort. Economists note that free access to fishery resources leads to overfishing, lower sustained yield, and higher costs. With overfishing and lower sustained yield previously cited as not a vaild concept in the Gulf shrimp fishery, the benefits to society from any benefit-cost measurement must come from reduction of harvest costs. Reducing the total harvest cost would involve reducing the number of firms (fishing effort) in the industry. There is evidence that other measures to reduce fishing effort, such as quotas, gear restrictions, shortened seasons, etc., actually increase capitalization and costs (Crutchfield and Zellner, 1962).

Although the annual nature of the shrimp crop provides some biological uniqueness, the Gulf shrimp fishery is subject to the sound scientific argument that all mature free access fisheries become overcapitalized (overcapitalization being the fishing effort or number of firms beyond that necessary to harvest the MEY). The extent of overcapitalization cannot be precisely stated at this time. Two investigations analyzed only vessel overcapitalization and utilized only one year's data. The results, even with these limitations, support the scientific arguments previously presented.

Very little analysis is required to show that the ideal world, perhaps MEY for the economist or MSY for the biologist, is better that the laissez-faire real world of free access to fishery resources (Coase, 1968). As pointed out above, however, methods to achieve MEY or even MSY may be more burdensome to the resource users, society, and government. Simply stated, the issue of overcapitalization and limited entry as a means of eliminating it really only require that a proposed shrimp harvest be judged better or worse than the existing harvest when all benefits and costs are considered. The problem of overcapitalization in the shrimp fishery, however, is not as simple as might first appear.

There are two issues, each dealing with the demand for shrimp, that also have an effect on the extent and importance of overcapitalization. The first is that Gates and Norton (1974) clearly demonstrate that the level of fishing effort (capital) yielding MEY is not necessarily the same as that representing maximum economic efficiency (MEE). MEE is realized at that level of fishing effort at which the value to society of the last unit of shrimp produced is equal to the cost to society of producing that unit. MEY is equal to MEE only when the price of shrimp is perfectly elastic, that is, when unlimited quantities can be purchased without the price rising. The demand for shrimp is quite different from this situation, and the result is that MEY and MEE are not identical. In this case MEE, not the rent maximization associated with MEY, is the appropriate economic goal. Futher, the MEE goal would induce a lower harvest than that of MEY, since the industry generates costs to society by using a common property resource. These cost involve the physical, human and monetary resources used in the fishery which could be better employed in other sectors of the economy. Their use in the fishery bids up their prices thereby creating inflationary pressures.

The second issue has to do with the impacat high levels of consumer demand have on the size of cost savings from decreasing the number of shrimping firms (capitalization). Bell (1972) and Cowers (1976) both recognize that, at high levels of consumer demand, maximization of yield (MEY) and

maximum economic efficiency (MEE) for all practical purposes are identical goals, even in view of the above argument. If such circumstances occur in the Gulf shrimp fishery, the overcapitalization may not be as serious as a cursory appraisal would suggest. Futhermore, while there is evidence of overcapitalization, the economic performance of harvesting firms, their owners, and employees, appears satisfactory. Also, the social ramifications of limited entry, such as alternative employment opportunities for those excluded, must be considered.

At present there is neither a suitable model nor adequate research to evaluate fully the socioeconomic issue of overcapitalization. The Council, therefore, has determined that, while capitalization (and effort) in the shrimp fishery may exceed MEE, the benefits of high levels of employment and the healthy economic condition of the shrimp industry outweigh any inflationary results.

3.5.2.4 Annual Participation in the Fishery

Table 3.5–10 lists the number of days fished per vessel and per boat, and the number of craft engaged in the subject fishery for each of the years from 1962 to 1974. It should be noted that days fished represent 24 hours of trawling time. Tables in Section 4.7 indicate the time spent trawling for each of the dominant species.

3.5.2.5 Total Man-Days Per Season

Annual estimates of the number of shrimpers on vessels and boats are given in Tables 3.5–11 and 3.5–12.

3.5.3 Domestic Commercial Processing Characteristics

3.5.3.1 Total Gross Income from the Shrimp and All Related Fisheries

Annual production for the Gulf region by product type of shrimp is shown in Table 3.5–13. Raw headless shrimp appear to generate the most revenue for Gulf processors: they constitute 45 percent of gross income in the 1967–1976 time period. Raw peeled shrimp make up 26 percent of the total, and breaded shrimp 17 percent. Although it involves a substantial amount of poundage processed, canning accounts for only ten percent of revenue, and the remaining two percent is split between dried shrimp and cooked and peeled shrimp.

3.5.3.2 Investment in Plant and Equipment

The number of seafood processing plants in the Gulf totaled 356 in 1976 (Table 3.5–14). No data are available for the capital assets or the yearly investment in shrimp processing either at national or at Gulf-wide levels. Data are available at the national level to construct an accurate capital series for all canned and cured seafood processing plants and for all fresh and frozen seafood processing plants. These data will be useful for comparative purposes if, at some future time, a shrimp processing capital series can be constructed.

3.5.3.3 Total Employment and Labor Income

Statistics for the Gulf shrimp processing industry cannot be isolated from the total fish processing data. Table 3.5–15 gives the pattern of employment and Table 3.5–16 shows the average hourly wage, for the nation and for the Gulf region. The annual rate of increase in fish processing employment has exceeded the national average for all manufacturing industries. Employment, reflected in both yearly average and seasonal high, declined for Louisiana and Texas in the 1970–1976 interval, while the other three states in the Gulf fishery all registered increases.

3.5.4 Recreational Fishing Characteristics

From 1955 to 1970, the number of marine recreational fishermen in the U.S. Gulf of Mexico more than doubled, from 1.1 million to 2.3 million, and expenditures by recreational fishermen more than quadrupled, from about $98 million to $405 million. A 1975 marine recreational survey conducted by the National Marine Fisheries Service suggested that the total poundage of shellfish, in terms of live weight, taken by recreational fishermen amounted to more than 56 million pounds, or about 25 percent of the finfish catch. The absence of accurate measures of total catch and effort allow only general inferences of their magnitude along the Gulf coast; therefore, precise delineation of the catch and effort may not be possible. There is no evidence to suggest, however, that recreational shrimping along the Gulf coast has failed to follow growth trends of other marine recreational fisheries.

BILLING CODE 3510-22-M

Table 3.5-11

Resident Vessel Shrimp Fishermen for the Gulf and Gulf States
(1958-1974)

Year	Total Gulf*	Florida West Coast	Alabama	Mississippi	Louisiana	Texas
1958	8,171	2,669	518	1,221	2,749	4,592
1959	8,225	2,520	577	1,261	3,235	4,222
1960	7,849	2,119	564	1,106	3,432	4,142
1961	7,186	2,091	442	1,152	2,613	4,268
1962	6,661	1,955	428	1,174	2,348	3,406
1963	7,252	2,601	459	1,157	3,380	3,824
1964	7,121	2,254	502	1,000	3,503	3,749
1965	7,223	2,105	706	1,010	3,341	3,657
1966	7,466	2,140	552	1,020	3,524	3,787
1967	8,219	2,161	561	972	3,782	4,723
1968	8,851	2,412	1,164	1,195	3,824	4,932
1969	9,266	2,350	1,283	1,166	3,987	4,975
1970	9,386	2,033	1,143	1,127	4,450	4,737
1971	9,042	1,897	1,160	881	4,063	5,247
1972	9,534	2,159	1,166	766	4,170	5,264
1973	10,573	2,710	1,438	904	4,948	6,312
1974	9,733	2,377	1,175	615	3,675	5,415
1975	9,507	2,425	1,179	573	3,552	4,751

Source: Fishery Statistics of the United States

* exclusive of duplication between states

Table 3.5-12

Resident Full-Time Boat Shrimp Fishermen for the
U.S. Gulf, by States (1958-1974)

Year	Total Gulf	Florida West Coast	Alabama	Mississippi	Louisiana	Texas
1958	4358	219	348	322	2824	645
1959	4280	149	340	270	2789	768
1960	4116	140	346	248	2836	570
1961	3903	147	315	208	2668	573
1962	4108	172	371	216	2815	565
1963	4443	203	395	220	3098	594
1964	4451	160	380	232	2974	705
1965	4457	178	335	235	2997	735
1966	4312	142	311	178	2919	772
1967	4195	110	279	168	2949	699
1968	3988	104	227	146	2910	601
1969	3771	88	188	150	2914	431
1970	3774	97	174	200	2791	512
1971	3879	93	171	254	2808	553
1972	3794	75	177	218	3188	475
1973	4078	94	158	200	3152	474
1974	3937	94	125	222	3130	366
1975	4159	75	147	216	3168	553

From Fishery Statistics of the United States.

Source: Processed Fishery Products, "Gulf Fisheries," various years.

Note: "Gross income" is the gross amount received by the producer at the production point; no deductions are made for commission or expenses.

Table 3.5-13

Production of Shrimp Products in the Gulf States, 1958-1977

Year	Breaded cooked and raw		Cooked and peeled	
	Gross Income (thousand $)	Pounds (thousand)	Gross Income (thousand $)	Pounds (thousand)
1958	$20,854	19,392	$2,265	2,368
1959	18,094	18,156	1,739	2,227
1960	25,608	25,530	2,379	2,851
1961	32,016	26,941	2,354	2,839
1962	33,399	25,870	1,925	1,965
1963	30,437	27,092	2,465	2,745
1964	35,459	31,661	2,243	2,745
1965	45,211	35,605	3,580	4,216
1966	52,001	36,349	3,707	3,705
1967	43,494	32,319	3,922	4,039
1968	53,257	35,687	4,327	3,569
1969	59,454	37,396	5,510	5,318
1970	55,990	35,462	4,586	5,751
1971	61,085	36,048	6,378	5,013
1972	76,451	38,763	4,004	4,038
1973	95,767	40,680	4,927	2,819
1974	75,173	32,888	4,788	3,032
1975	68,066	26,716	4,319	2,535
1976	92,835	28,935	3,549	1,832

Year	Raw Headless Shrimp		Raw Peeled	
	Gross Income (thousand $)	Pounds (thousand)	Gross Income (thousand $)	Pounds (thousand)
1958	$43,474	57,284	$4,402	5,309
1959	32,914	55,486	6,056	9,437
1960	45,263	74,730	10,519	13,702
1961	31,993	42,297	13,058	15,402
1962	43,743	47,646	14,360	14,825
1963	44,748	62,143	17,258	18,676
1964	44,271	55,295	19,155	21,957
1965	48,689	58,928	21,286	23,430
1966	54,207	56,242	26,443	25,664
1967	81,121	91,860	33,033	30,842
1968	76,448	74,205	37,715	31,068
1969	88,031	80,452	42,260	30,852
1970	91,342	88,061	45,540	40,228
1971	112,342	87,860	48,934	36,893
1972	125,159	86,824	47,380	31,917
1973	149,473	43,642	43,371	24,671
1974	114,077	65,537	33,937	24,145
1975	132,084	56,183	34,824	25,249
1976	255,877	85,459	67,685	32,437

Year	Canned		Dried	
	Gross Income (thousand $)	Pounds (thousand)	Gross Income (thousand $)	Pounds (thousand)
1958	$16,759	22,034	$493	1,688
1959	13,259	21,207	291	1,555
1960	14,853	24,428	796	3,430
1961	8,760	13,142	745	2,019
1962	16,502	21,584	598	1,796
1963	17,503	27,765	380	2,194
1964	11,929	17,812	461	1,092
1965	19,560	27,724	547	1,329
1966	20,383	26,057	685	1,640
1967	19,833	26,489	562	1,701
1968	22,079	27,527	1,066	2,707
1969	20,898	27,663	1,135	3,141
1970	26,730	34,664	n.a.	n.a.
1971	23,787	29,130	1,356	3,498
1972	29,160	29,937	1,439	2,876
1973	38,024	27,420	1,250	1,558
1974	31,137	26,131	1,401	2,482
1975	17,486	14,235	2,931	2,879
1976	32,606	22,511	1,748	2,217

BILLING CODE 3510-22-C

Most of the shrimp caught by recreational fishermen are taken with otter trawls ranging from 16 to 40 feet in width. Seines, cast nets, dip nets, butterfly nets, and push nets are also used in some areas. It is not possible from available data to determine what portion of the total recreational shrimp catch is used for home consumption and what may be sold commercially.

State-by-state summaries of the recreational shrimp fishery are:

Florida West Coast: No permit is required; total catch and effort are not quantified. The number of boats is estimated at 500 to 650 (Charles R. Futch, Florida Department of Natural Resources, personal communication).

Alabama: About a third of the owners of boats in the coastal counties less than 26 feet in length owned 16-foot trawls, for which no licenses are required (Swingle, et al., 1976). There are more than 6,000 such boats. Swingle, et al. (1976) estimate that recreational shrimpers harvested 15 to 25 percent of the total catch in the inland waters (Table 3.5–17). Because of catch limitations, some recreational shrimpers often purchase commercial licenses during open commercial seasons to avoid poundage restrictions imposed on sport shrimpers.

Mississippi: Weaver and Christmas (n.d.) estimate that recreational shrimpers constituted an average of 67 percent of the licensed shrimpers in 1974–1976 and took more than a half million pounds of shrimp or about one-eighth of the reported inshore commercial catch during the three-year period (Table 3.5–17).

There is no distinction between commercial and recreational shrimpers under the law. In their study, Weaver and Christmas classified recreational shrimpers as those who reportedly did not sell their catches.

Louisiana: More recreational shrimpers are located in Louisiana than in any other state. It is estimated that in 1973 sport shrimpers in Louisiana equipped some 30,000 boats with otter trawls and harvested some 23.6 million pounds (heads-on) of shrimp, Table 3.5–17 (U.S. Army Corps of Engineers n.d.). At the present time, both the number of boats equipped with trawls and the total catch are probably much higher. No license is required for recreational trawls up to 16 feet. Licenses are required for trawls in the 17- to 50-foot range. The smaller trawl operators may take up to 100 pounds of shrimp, heads-on, per day with no size limitations. A sport trawling license permits the shrimper to take as many shrimp each day as he can, provided the shrimp are not sold. Recreational shrimpers often purchase commercial licenses which permit them to shrimp on a part-time basis and sell all or part of the catch. Most of the shrimp sold go to outlets which are not statistically monitored, so the magnitude of this commercial catch cannot be defined.

Texas: King (1975) estimated that 1.1 percent of the Texas shrimp harvest was caught by recreational shrimpers in 1973. Recreational shrimpers harvested about 846,000 pounds from Texas' bays and about 55,000 pounds from the Gulf waters adjacent to Texas (Table 3.5–17). Licenses are required of Texas recreational fishermen. An additional license is required for trawls. Cast nets, dip nets, traps, and minnow seines do not require licenses. Catch limits are two quarts per person during any inland waters closed season. Up to 100 pounds may be taken in major bays during the open season, August 15 to December 15 and from Gulf waters under state jurisdiction during the July 16 to May 31 season. The limit is 15 pounds in major bays during the May 15 to July 15 season. Recreational shrimpers are prohibited from selling any portion of their catch and are subject to the same size restrictions as commercial fishermen.

Personal Communications from Fishery Managers

The following information on recreational shrimping was collected by means of personal communications with fishery management personnel from each of the five Gulf states.

BILLING CODE 3510-22-M

Table 3.5-14

Number of Processing Plants in the Gulf Coast States 1970-1976

	Total Gulf	Florida West Coast	Alabama	Mississippi	Louisiana	Texas
1970	435	138	44	43	122	88
1971	428	127	48	44	128	81
1972	417	118	51	42	124	82
1973	407	118	51	40	118	80
1974	360	103	44	37	112	64
1975	350	106	43	37	104	60
1976	356	113	43	36	109	55

From Fishery Statistics of the United States and Processed Fishery Products, Annual Summary.

Table 3.5-15
Yearly Average and Seasonal High Employment in Fish Processing

	Total Gulf		Florida West Coast		Alabama	
	Yearly Ave.	Sea. High	Yearly Ave.	Sea. High	Yearly Ave.	Sea. High
1970	11,527	15,659	3,507	4,137	875	1,383
1971	11,488	15,912	3,562	4,321	1,018	1,590
1972	11,477	15,372	3,409	3,971	1,158	1,732
1973	11,405	15,440	3,477	3,951	1,196	1,786
1974	9,316	13,245	2,953	3,473	1,040	1,496
1975	9.058	12,028	2,860	3,319	1,005	1,419
1976	10,399	13,590	3,393	4,014	1,297	1,839

	Mississippi		Louisiana		Texas	
	Yearly Ave.	Sea. High	Yearly Ave.	Sea. High	Yearly Ave.	Sea. High
1970	990	1,458	3,177	4,612	2,978	4,069
1971	1,025	1,604	3.122	4,699	2,771	3,698
1972	1,087	1,564	3,262	4,775	2,561	3,328
1973	1,016	1,466	3,233	4,807	2,483	3,430
1974	1.088	1,516	2,953	4,242	1,282	2,518
1975	1,035	1,468	2,733	3,780	1,425	2,042
1976	1,124	1,530	2,865	3,958	1,720	2,249

From Fishery Statistics of the United States and Current Fisheries Statistics.

Table 3.5-16

Hourly Wage Rates for Fish Processing 1958-1976

	Canned and Cured		Fresh and Frozen	
	Nation	Gulf	Nation	Gulf
1958	$1.57	$1.10	$1.17	$ .82
1959	1.68	1.18	1.19	.83
1960	1.79	1.25	1.20	.84
1961	1.79	1.25	1.28	.90
1962	1.88	1.32	1.41	.98
1963	1.91	1.34	1.41	.98
1964	1.94	1.36	1.46	1.02
1965	2.07	1.56	1.65	1.24
1966	2.12	1.59	1.71	1.28
1967	2.19	1.64	1.80	1.35
1968	2.28	1.72	1.90	1.42
1969	2.34	1.86	2.04	1.62
1970	2.74	2.19	2.00	1.60
1971	2.86	2.29	2.17	1.73
1972	3.09	2.81	2.59	2.36
1973	3.34	3.04	2.72	2.48
1974	3.60	3.27	3.07	2.79
1975	3.87	3.52	3.32	3.02
1976	4.50	4.10	3.65	3.31

From Census of Manufacturers and Annual Survey of Manufacturers, US Department of Commerce.

BILLING CODE 3510-22-C

Table 3.5-17.—*Gulf of Mexico Recreational Shrimp Fishery: The Survey Methods, Number of Sport Trawls, Estimated Total Effort (m.h. = Man Hours, a.d. = Angler-Days and m.d. = Man-Days), Estimated Total Catch and Data Source by State and Year*

State	Year	Survey method	Number of sport trawls [1]	Estimated total effort	Estimated total catch (lbs. heads-on)	Data source
Florida west coast			([2])	([2])	([2])	([2])
Alabama [3]	1972	Postal and telephone survey	[4]5,727	([5])	277,051	Swingle et al. 1976
	1973	Personal interview	5,727	309,644 m.h.	204,577	Swingle et al. 1976
	1974	Personal interview	5,727	189,944 m.h.	290,541	Swingle et al. 1976
Mississippi	1974	Personal interview	1,535	19,958 a.d.	166,667	Weaver and Christmas n.d
	1975	Postal and telephone	1,770	15,410 a.d.	176,353	Weaver and Christmas n.d
	1976	Survey	1,874	16,571 a.d.	182,111	Weaver and Christmas n.d.
Louisiana	1968	Telephone survey	14,000	378,000 m.d [6]	19,000,000	U.S. Fish and Wildlife Service 1972.
	1973	([7])	30,000	472,000 m.d.	[illegible],000,000	U.S. Army Corps of Engineers n.d
Texas	1973	Postal and telephone survey	10,117	([5])	[illegible],000,000	King 1975.
					118,080	

[1] The number of recreational trawls (16 feet in length) in Baldwin and Mobile Counties, Alabama, was estimated for 1972 based on the assumptions that all recreational trawls were owned by boat owners and that all recreational shrimping was conducted from boats ≤ 26 feet in length. The estimated number of recreational trawls in Louisiana during 1973 was based on the assumption that 25 percent of the licensed sport boats were equipped with trawls to harvest shrimp. The total number of trawls in Mississippi was based on the results of a survey of licensed trawl holders who reported no sale of catch. In Texas, the total number of recreational trawls was determined from direct counts of the number of "Individual Bait-Shrimp Trawl" licenses sold during 1973.

[2] No data available.

[3] All estimates are for Baldwin and Mobile Counties only.

[4] Catch Estimates for 1973 and 1974 were based on the assumption that there was no change in the number of trawls owned since 1972.

[5] Not determined.

[6] Based on the assumption that 14,000 shrimpers fished an average of 27 man-days each in 1968.

[7] The estimated total catch and effort for 1973 were projections based upon the results of the 1968 survey.

Florida West Coast: Most of the interest in recreational shrimping appears to be centered in the Apalachicola Bay region. The boats used in the fishery range in size from about 15 feet to large cabin cruisers, and include a number of small (20–25 feet) fully-rigged shrimp boats. Most of the recreational effort is expended on weekends during summer and autumn by residents of the coastal counties and adjacent inland counties. Trawls range in size from 14 to 18 feet with an average size of 16 feet. Other gear types are seldom used to harvest shrimp for home consumption. The popularity of recreational shrimping in Florida appears to be related to the retail price of shrimp rather than to the availability of the resource. The number of participants in the recreational shrimp fishery may increase if shrimp prices continue to rise. (Charles R. Futch, Assistant Chief, Bureau of Marine Science and Technology, Florida Department of Natural Resources, Tallahassee, 9 May 1978).

Comparatively little recreational shrimping occurs on the Florida west coast. Some recreational effort may occur out of the Cedar Key area by inland county residents traveling to the coast for the weekend. There may have been a decline in the number of participants in the recreational shrimp fishery in the past few years because of the rising prices of fuel, nets, and equipment. Also, obtaining the necessary information on how to shrimp may be more difficult here than in other areas (Jeffrey A. Fisher, Marine Advisory Agent, Panama City, 10 may 1978).

Alabama: Enforcement officers have observed an apparent increase in the number of recreational shrimp boats in the past few years which is believed to be mainly due to the rising retail price of shrimp. The number of participants will probably increase if shrimp prices continue to rise. Most of the recreational effort is expended in the Mississippi Sound and lower Mobile Bay where the greatest concentrations of brown shrimp occur. Some recreational effort may occur in Wolf and Perdido Bays but is small by comparison. Recreational shrimpers reside primarily in Baldwin and Mobile counties, although some live in the inland counties and travel to the coast to shrimp. Residents of other states have been periodically observed trawling recreationally in Alabama. Most of the recreational effort occurs on the weekends, and to a lesser extent, after work on weekdays. The boats generally range from 14 to 30 feet in length, with the majority in the 14 to 20 foot class. Most of the recreational catch is harvested with 16-foot otter trawls. Owners of 16-foot trawls sometimes purchase commercial licenses to avoid the poundage limitations imposed on recreational shrimpers. (Steven R. Heath, Marine Biologist, Alabama Department of Conservation and Natural Resources, Dauphin Island, 11 May 1978.)

Mississippi: Recreational shrimping occurs primarily in Mississippi Sound between Biloxi and Pascagoula, with a comparatively small effort in the vicinity of Waveland. Most recreational shrimping is conducted using a small boat (30 feet long or less) outfitted with a single 16-foot trawl with one to two people aboard. The majority of the recreational shrimpers reside in Harrison and Jackson counties; relatively few live in Hancock county. The number of licensed trawls in Mississippi has increased sharply in the last three years. (Tom Van Devender, Fishery Biologist, Gulf Coast Research Lab, Ocean Springs, 8 May 1978.)

Louisiana: There are a large number of participants in the recreational shrimp fishery. About 25 percent of the estimated 200,000 recreational boats registered in Louisiana are equipped with otter trawls. Although the majority of the recreational catch is taken in otter trawls, some effort occurs with wing nets and cast nets. Wing nets may be attached to fixed platforms or boats; cast nets are used in the Rockefeller Refuge, lake Pontchartrain vicinity, and other accessible marsh areas. The boats used for recreational shrimping range in length from about 14 feet and up. Most of the residents of the coastal parishes who own boats 16 feet in length have otter trawls. Many recreational shrimpers are residents of larger cities and choose to shrimp in the wetland areas nearby. However, on a typical trip, recreational shrimpers travel 50 to 80 miles to shrimp in coastal areas Comparatively few people from the northern part of the state above Baton Rouge travel to the coast to shrimp. There is no known recreational shrimping by residents of other states. (Harry Schafer, Chief; William S. Perret, Federal Aid Coordinator; Judd Pollard, Biologist, Division of Oysters, Water Bottoms and Seafoods, Louisiana Wildlife and Fisheries Commission, New Orleans, 6 June 1978.)

Texas: The general increase in the number of "Individual Bait-Shrimp

Trawl" licenses sold in recent years suggests that the number of participants in the Texas recreational shrimp fishery has shown the same growth trends as the other Gulf states. The growth of the recreational shrimp fishery in Texas may be attributed to (1) population growth in the coastal areas, (2) an increase in leisure time, and (3) the rising retail price of shrimp. The boats used by recreational shrimpers average about 16 to 21 feet in length. Most of the shrimpers reside in coastal counties or adjacent inland counties. There is no known recreational shrimping effort by residents of other states. The majority of the recreational catch is taken with otter trawls. (Roy B. Johnson, Regional Director, Coastal Fisheries, Texas Parks and Wildlife Department, La Porte, 13 June 1978.)

3.5.5 Subsistence Shrimping

Accepting the definition of a subsistence shrimp fisherman as one who catches just enough shrimp to provide for immediate sustenance of his family, no individuals, communities, or sicieties fitting into this category could be identified as part of the Gulf of Mexico shrimp fishery. There are apparently some fishermen who partially subsist on shrimp. In a broader sense, there are substantial numbers of south Louisiana residents who alternate their subsistence activity from shrimping to crabbing, trapping, and hunting and who have little or no income other than that derived from these activities.

3.5.6 Indian Treaty Fishing Characteristics

No treaties with Indians (Native Americans) which would affect a Gulf of Mexico fishery management plan have been located. One lawsuit, pending in Federal District Court for the Eastern District of Louisiana, seeks to enjoin enforcement of all Louisiana wildlife and fishery laws "unsupported by legitimate conservation considerations" as applied to three tribes domiciled in Louisiana. It seeks to overturn Louisiana laws regulating gill nets and seines, defining the line of demarcation between inside and outside waters for shrimping, and regulating nets and gear used for taking shrimp, by having them delcared unconstitutional as applied to Houmas, Chittimacha, and Choctaw Indians on the grounds that treaties entered into between France and Spain and various Indian tribes were carried over in full force by the terms of the Louisiana Purchase.

3.5.7 Output of Domestic Commercial Bait-Shrimp Fishery

A bait-shrimp industry of considerable economic importance has arisen in some areas of the Gulf of Mexico due to the popularity of shrimp, live or dead, as bait for numerous varieties of saltwater game fish (Section 4.1, Predation). Each of the Gulf states has laws regulating the bait-shrimp industry. Generally there are no restrictions as to season, count size, or closed areas. The bait fishery is based primary on the juveniles of brown, pink, and white shrimp, with pink shrimp dominant for Florida and brown and white shrimp dominant in the other states.

Otter trawls, side-frame trawls, cast nets, seines, and baited traps are used to harvest bait. The catch is sorted rapidly, and shrimp are placed in aerated live-bait wells. Live-bait shrimping operations are conducted primarily at night.

A state-by-state summary:

Florida: An average of 74.75 million shrimp, valued at $1.42 million, was produced in the 1968–1975 period (Table 3.5–18). The number of permits issued increased from a 1968–1969 low of 182 to 761 in 1974 (Table 3.5–18). A decline in the total catch has accompanied the increase in permits (Table 3.5–18).

Alabama: Swingi (1972) reports that 24 bonafide bait dealers in Baldwin and Mobil counties sold 1,544,000 live shrimp with a retail value of $64,500 during. In addition to the live bait sales, a total of 22,200 pounds of dead shrimp was sold for bait with a retail value of $12,040. Bait-shrimping is a part-time occupation, primarily during the May–September period, for most of the bait dealers; 40 licenses were issued for 1977–1978 fiscal year (Steven R. Heath, Alabama Department of Conservation and Natural Resources, personal communication.)

Mississippi: Christmas, et al. (1976) estimate that bait-shrimpers in the coastal counties of Mississippi harvested a total of 60,317 pounds of live shrimp with a retail value of $96,804 during May to November, 1971. In addition, they estimate that 44,860 pounds of shrimp valued at $25,875 were used as dead bait during the same period.

Louisiana: Saltwater finfisherman in Louisiana used an estimated 1,529,000 pounds of bait-shrimp during 1973 (U.S. Fish and Wildlife Service data 1976, cited in U.S. Army Corps of Engineers n.d.). Live bait-shrimping in Louisiana comes under strict regulation, and a $1,000 property, cash, or performance bond must be posted by the dealer as surety for observance of regulations. The number of licenses issued during 1971–1978 varied between 11 and 28 per year; a recent high was 28 in 1974, and the 1978 total was 12 (W.S. Perret, LDWF personal communication).

Texas: Chin (1960) estimates that a total of 460,995 pounds of live bait-shrimp and 206,624 pounds of dead bait-shrimp were harvested from Galveston Bay from June 1957 to May 1959. The total retail value of the catches were $653,520 and $112,761 for live and dead bait-shrimp, respectively. Stokes (1974) estimates that a total of 53,181 quarts of live bait-shrimp with a retail value of $265,905 were harvested in the Lower Laguna Madre area from November 1970 through October 1972. NMFS estimates that a total of 2,340,000 pounds of live and dead bait shrimp valued at $6,790,000 were harvested on the Texas coast in 1978. There were approximately 1,500 commercial bait-shrimp boat licenses issued that year.

3.5.8 Area Community Characteristics

3.5.8.1 Total Population

A very substantial settlement of the coastal area has occurred during the twentieth century, resulting in substantial changes to the estuarine habitat of the Gulf populations (Lindall and Saloman, 1977).

The most recent population trends in the coastal area are presented in Figure 3.5–11. The coastal parishes/counties display no uniform pattern of recent population change. However, on a state-by-state comparison the coastal parishes/counties that have been experiencing the most rapid growth tend to be situated along the Florida coast. Several Louisiana, Alabama, Mississippi, and Texas counties that show moderately strong growth appear to do so in conjunction with the spread of population in and around metropolitan areas. Rapid growth of Florida counties has long been associated with retirement.

The shrimp industry makes its presence felt in virtually all ports that lie on or near the Gulf of Mexico. However, in only a handful of ports could it be considered the dominant industry. The ports tend also to be sites of shipbuilding, petrochemical manufacture, and marine transport.

3.5.8.2 Total Employment in Shrimp Fishery

Peak average employment associated with the Gulf shrimp fishery for 1974 was 28,295, with a seasonal peak of 32,850. Employment is delineated in the accompanying table, covering processing, wholesaling, and vessel and boat fisherman for the year. Data is from Fisheries Statistics of the U.S., 1974.

Table 3.5–18—*Total number of bait-shrimp permits issued, total live shrimp production, and value of the catch in Florida for the years 1968 through 1975 (after Christmas and Etzold 1977)*

Year	Permits	Live shrimp production (× 10^6 individuals)	Value (× 10^6 dollars)
1968	182	87.02	1.49
1969	182	88.55	1.76
1970	399	78.72	1.40
1971	401	67.04	1.23
1972	544	73.64	1.32
1973	361	70.31	1.34
1974	761	61.30	1.29
1975	690	71.48	1.55

Table 3.5–18—*Total number of bait-shrimp permits issued, total live shrimp production, and value of the catch in Florida for the years 1968 through 1975 (after Christmas and Etzold 1977)*—Continued

	Seasonal seafood processing employment	Yearly [illegible]	Seasonal seafood wholesaling employment	Yearly [illegible]	Full time	
					Fishermen vessels	Boats
Florida west coast	3,473	2,953	557	515	2,377	94
Alabama	1,496	1,040	140	91	1,175	125
Mississippi	1,516	1,035	127	80	815	112
Louisiana	4,242	2,953	643	358	3,675	3,130
Texas	2,518	1,282	1,139	741	5,415	366
Total gulf	13,245	9,316	2,411	1,785	13,257	3,937

3.5.8.3 Relationship of Shrimp Fisheries to Total Work Force

Census information about numbers of shrimp fishermen is unavailable as it is masked among counts of people employed in agriculture, forestry, and fisheries. A frequency distribution of Gulf counties, in terms of the percent of the labor force that was employed, is given in Figure 3.5.–12. It does not appear that shrimp fishing is a major contributor to overall employment in most of Gulf counties. The highest proportion employed in agriculture, forestry, and fisheries combined was 30 percent.

Table 3.5–19 compares, by county, the number of people identified as employed in the fisheries, mining, contract construction, and petrochemical manufacturing industries (county business patterns) for Texas and Louisiana counties identified as major centers of shrimp industry activity. The data indicate that the shrimp industry is overshadowed in all these units by other marine-oriented industries alone. The data suggest that the shrimp industry could not contribute, even at its peak, much more than 25 percent to the employment profile of any of these Gulf counties. In most cases, the peak contribution very likely is far less than 25 percent.

The presence of other industries in the shrimp ports is a mixed blessing to the shrimpers. Offshore oil, in particular, can provide off-season employment. However, in a number of ports shrimpers have had to relinquish berthing space to offshore oil or oceanic transshipment, both of which provide more revenue to port authorities.

3.6 Interaction Between and Among User Groups

3.6.1 Shrimpers Interactions

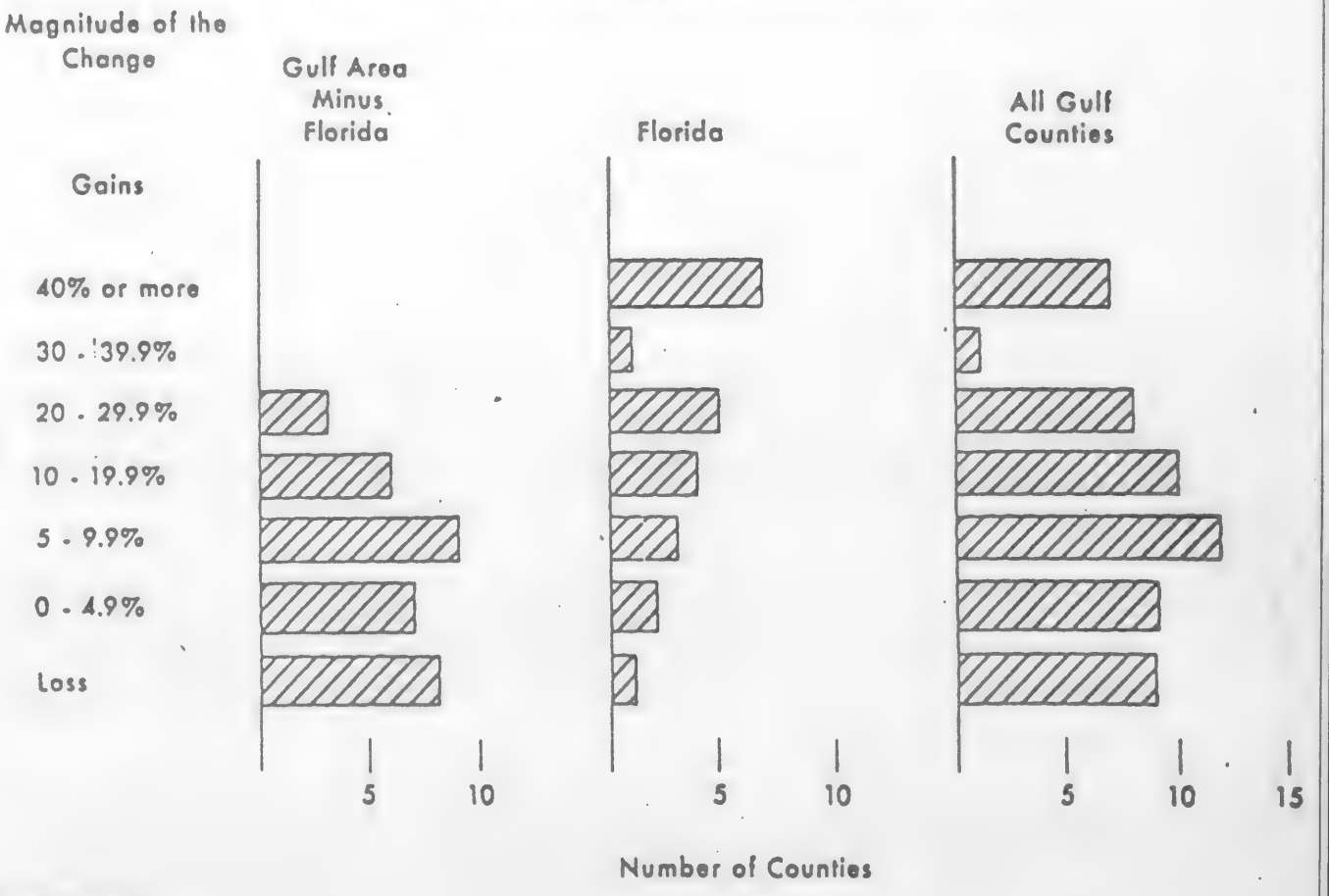
Inland shrimp operations most likely involve family members or close friends as crew. Where the relationship is close, the income may not specifically be divided but shared.

If the offshore vessel is operated by its owner, the usual arrangement is for the vessel to get a portion of the value of the catch and for the owner/captain and crew to divide the remainder. The vessel share goes toward maintenance and repair of the vessel, fuel, and ice.

If the operator is not the owner, a different relationship exists. The captain and crew share from 42 to 33 percent of the "take"—the net value of the shrimp minus a share of such operating expenses as fuel, ice, processing charges, and gear repair.

BILLING CODE 3510-22-M

Figure 3.5-11. Estimated Change in Population, 1970-75



BILLING CODE 3510-22-C

There is another complex set of relationships—between the owner and the dealer where the shrimp are unloaded. In some areas there is no apparent bond; in others, with such fluctuations as periodic ice shortages or marked shrimp supply-demand fluctuations, a fairly permanent relationship may develop. The relationship seems to work to the benefit of both dealer and owner in some cases, for example, when ice or shrimp supplies are scarce. This kind of relationship, in which both parties are mutually interdependent, appears to be an amicable one with few signs of antagonism or conflict. In other areas, where it is customary for a dealer rather than a banker to advance operating capital to the shrimper, the lack of independence in business transactions apparently can lead to antagonism.

3.6.2 Prevalent Conflicts With Shrimpers and Other National Interests

Gulf shrimp are harvested by one of the largest and most diverse group of fishermen in the nation. Harvest occurs from the shallow-water estuarine areas out to open Gulf waters of 300 fathoms. The reported commercial fleet averaged 8,300 boats and vessels trawling an average of some 5.2 million hours annually during the 1970–1974 period. All information indicates a general increase in these figures. In addition there is a large, growing, relatively uncounted recreational fleet as well as a substantial number of commercial bait shrimpers. Conflicts of this large group with other national interests may involve:

- Capture of finfish and shellfish, which are harvested and then discarded;
- Incidental capture of sea turtles;
- Loss of estuarine habitat necessary for growth and survival of brown, white and pink shrimp;
- Gear conflicts with stone crab fishermen in southern Florida;
- Construction (accidental or intentional) of underwater obstructions to shrimp trawling.

Measures are suggested in Section 8.3 to alleviate these conflicts through consideration of the needs both of shrimpers and of other national interests. Two of these conflicts (those over sea turtles and finfish) and treated in more detail in this section.

3.6.2.1 Incidental Catch of Finfish by Shrimpers and of Shrimp by Groundfish Fishermen

The discard of the incidental catch of finfish during commercial shrimping operations in the Gulf of Mexico is a matter of concern to fishery managers. During the process of sorting shrimp from the remainder of the catch brought in by a trawl, most of the incidental catch die from trawling, handling, and exposure before they are discarded. In recent years this problem has become accentuated by the movement of shrimp trawlers into offshore areas traditionally used by the groundfish fleet.

Seidel (1975) estimated that four to 12 pounds of finfish are taken for each pound of shrimp harvested. The annual finfish discard was approximated in Table 3.6–1 by multiplying the low and high estimates (four and 12 pounds, respectively), by the total yearly shrimp catch in the Gulf of Mexico. The analysis of experimental tows taken in the north central Gulf by the National Marine Fisheries Service, Pascagoula Laboratory, indicates that the fish-to-shrimp ratios vary widely by season, locality, year, and fishing strategy. The fish-to-shrimp ratios presented in Table 3.6–2 are composite figures computed from many tows taken in the inshore and offshore areas of the north central Gulf. Up to 70 percent (by weight) of the discard are species usable by the groundfish industry.

During the period of concentrated shrimping effort in estuarine nursery areas, shrimp trawls capture and kill large numbers of juvenile groundfish and other species. At present it is not known if current levels of trawl-induced mortality of juvenile fishes in estuaries have a detrimental effect on offshore groundfish populations.

The income from marketable incidental catch taken in shrimp trawls and reported to NMFS in 1974 was (by states): Florida, 1.7 percent of the value of the shrimp landings; Alabama, 13 percent; Mississippi, 7 percent; Louisiana, 0.8 percent; and Texas, 0.5 percent (Figures 3.6–1 through 3.6–5).

There is no information currently available on the magnitude of the incidental catch discarded by recreational shrimpers in the Gulf of Mexico. Most of the recreational catch and effort occurs in estuarine areas. The total amount of finfish discards, based on the estimated number of participants in the recreational shrimp fishery, may be substantial in some states. Louisiana has by far the largest number of participants in the recreational shrimp fishery, followed by Texas, Alabama, Mississippi, and Florida.

No quantitative data are available on the mortality of the incidental catch taken during live bait-shrimping operations. Bait shrimpers operate primarily at night in the inshore areas of the Gulf of Mexico. The mortality of the incidental catch is probably minimized by: (1) the short duration of the tows; (2) the speed at which the catch is sorted; and (3) cooler, humid conditions at night.

Juhl (1974) estimates that the average incidental catch of shrimp was eight pounds and seven and a half pounds (heads-on) per hour of fishing effort by industrial and foodfish trawlers, respectively. Although substantial quantities of shrimp are caught and marketed by the industrial and foodfish fleet (Gutherz, et al., 1975), these catches are not specifically listed in the annual summaries of landing statistics published by the National Marine Fisheries Service.

3.6.2.2 Habits, Distribution, and Incidental Capture of Sea Turtles in the Gulf of Mexico

(See Appendix FEIS for detail information)

Six of the seven species of sea turtles in existence are found in the U.S. Gulf of Mexico. These sea turtles are sometimes accidentally caught during trawling operations for shrimp and groundfish. The listing of the Kemp's ridley, hawksbill, leatherback, and Florida populations of the green turtle as endangered species, and of the green, loggerhead, and olive ridley turtles as threatened species, necessitated a careful consideration of the effect of shrimping on these species. A considerable effort was made to document what was known about the life history and factors affecting the decline in their numbers, and shrimping operation measures which would alleviate these problems. (See Appendix FEIS.)

Exploitation and habitat loss are two major causes of the drastic decline in sea turtle numbers. Incidental capture by shrimp and groundfish fishing operations is increasingly important as populations decline. Preservation measures are aimed at reducing adult and subadult mortality and increasing juvenile recruitment.

The accidental capture of sea turtles during shrimp and groundfish fishing activities is a major problem along the southern Atlantic and Gulf coasts (Ogren, et al., 1977). An estimated 800 to 1,000 sea turtles are caught each year off the south Atlantic coast (based on Hillestad, et al., 1977; Ulrich, 1978). Similar estimates for incidental turtle catch in the Gulf of Mexico are not available.

All of the Gulf states have laws aimed at conservation of sea turtles. At the federal level, designation of critical habitat areas is under consideration. Headstarting—protection during incubation and the first year of life—still is in the experimental stage. Predator control, primarily for raccoons, can protect nests from destruction.

BILLING CODE 3510-22-M

Figure 3.5-12. The percent of all county residents employed who were active in Agriculture, Forestry, and Fisheries.

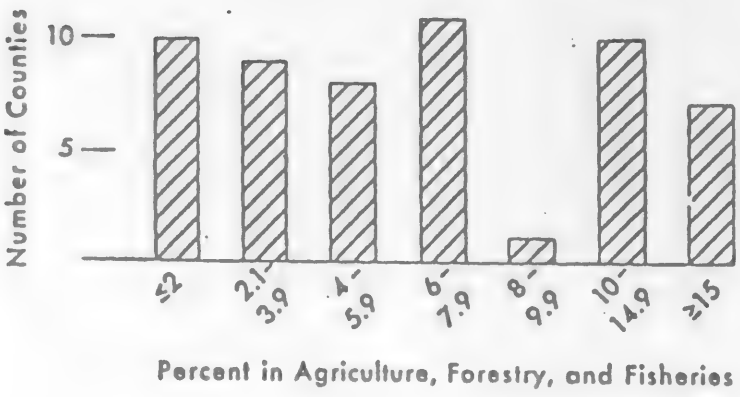


Table 3.5-19

Employment Patterns in Major Shrimp Counties
of Texas and Louisiana, 1976

Number of employees	Seafood				Other		
	Fishing Hunting Trapping	Whole-salers	Canned Cured Seafood	Fresh or Frozen Shrimp	Contract Construction	Mining	Petrochemical Manufacturing
Louisiana							
Calcasieu					3531	612	1816
Jefferson	86	157	160	289	13288	7052	509
LaFourche	316				981	956	
Terrebonne	191	93	113	(100-249)	1886	7312	(100-249)
Texas							
Brazoria	128	60			6432	675	(5000-9999) +(2500-4999)
Cameron	1075	59		(500-999)	7770	89	(100-249)
Galveston	108	50			3125	505	6532
San Patricio [1]	300				457	1048	(500-999)

[1] Note that no establishments are reported in any of the seafood trade or processing categories. This is despite the fact the Aransas Pass, in San Patricio County, touts itself the world's shrimp capital. Aransas Pass does have a sizeable shrimp wholesaling and processing industry. Again, this time for county business patterns, the data are not very adequate even for our modest purposes.

Table 3.6-1. Annual Gulf of Mexico shrimp catch and estimated finfish discards using fish:shrimp ratios of 4:1 and 12:1, 1959-1975. Shrimp catches were converted to heads-on poundages from headless data furnished by the U.S. Department of Commerce, 1959-1975. Discard ratios encompass the range reported by Seidel (1975) and are presumably based on round (live) weight.

Year	Shrimp catch (heads-on)[1] (million pounds)	Estimated discard 4:1 ratio (million pounds)	Estimated discard 12:1 ratio (million pounds)
1959	143.4	573.6	1,720.8
1960	166.1	664.4	1,993.2
1961	90.7	362.8	1,088.4
1962	106.6	426.4	1,279.2
1963	176.5	706.0	2,118.0
1964	150.1	600.4	1,801.2
1965	167.7	670.8	2,012.4
1966	163.4	653.6	1,960.8
1967	207.7	830.8	2,492.4
1968	180.4	721.6	2,164.8
1969	187.8	751.2	2,253.6
1970	215.6	862.4	2,587.2
1971	211.4	845.6	2,536.8
1972	208.2	832.8	2,498.4
1973	165.3	661.2	1,983.6
1974	169.1	676.4	2,029.2
1975	157.9	631.6	1,894.8

1/ Heads-on poundages were estimated from headless data using conversion factors for each species and average percent species composition of Gulf catches from 1959-1975: brown shrimp -- 1.61, 55%; white shrimp -- 1.54, 32%; pink shrimp -- 1.60, 11%; sea bobs -- 1.53, 1%; royal red shrimp -- 1.80, 0.8%; rock shrimp -- 1.67, 0.2%. The conversion factors for all species except rock shrimp are from the U.S. Department of Commerce (1959-1975). The conversion factor for rock shrimp was computed from data published by Cobb et. al. (1973).

Table 3.6-2. Comparison of fish discard ratios derived from trawl data collected in the inshore and offshore areas of the Gulf of Mexico between 87° 30' and 91° 31', 1973-1977 (data collected and summarized by the National Marine Fisheries Service, Pascagoula, Mississippi).

Year	Inshore		Offshore	
	Sample size	Ratio	Sample size	Ratio
1973	52	4.9	(1)	(1)
1974	19	1.0	15	4.3
1975	47	5.9	52	20.3
1976	27	3.6	53	12.6
1977	24	2.7	19	6.0

(1) No data.

Table 3.6-3. Estimated annual discard (metric tons) of the six major species of finfishes taken during inshore and offshore shrimping operations in the Gulf of Mexico from 87° 30' to 90° 30', 1969-1976. Percentages in parentheses refer to the percent composition of the total catch for each species and are composite figures derived from data collected during 1973-1977 (data collected and summarized by the National Marine Fisheries Service, Pascagoula, Mississippi).

Year	Inshore						Offshore					
	Atlantic Croaker (32.8%)	Sand Seatrout (10.6%)	Spot (10.6%)	Sea Catfish (7.5%)	Atlantic Cutlassfish (6.0%)	Silver Seatrout (1.7%)	Atlantic Croaker (55.1%)	Sand Seatrout (6.1%)	Atlantic Cutlassfish (5.0%)	Spot (3.3%)	Silver Seatrout (2.0%)	Sea Catfish (1.7%)
1969	28,854	9,325	9,325	6,598	5,278	1,495	133,298	14,759	12,096	7,983	4,838	4,113
1970	29,890	9,659	9,659	6,834	5,468	1,549	140,576	15,563	12,756	8,419	5,102	4,337
1971	33,196	10,728	10,728	7,590	6,072	1,720	153,543	16,998	13,933	9,196	5,573	4,737
1972	26,274	8,491	8,491	6,006	4,806	1,362	142,417	15,767	12,924	8,530	5,169	4,394
1973	18,369	5,936	5,936	4,200	3,360	952	89,939	9,957	8,161	5,386	3,264	2,775
1974	19,504	6,303	6,303	4,460	3,568	1,011	92,583	10,250	8,401	5,545	3,360	2,856
1975	16,183	5,230	5,230	3,700	2,960	839	96,713	10,707	8,776	5,792	3,510	2,984
1976	29,430	9,511	9,511	6,730	5,384	1,525	134,188	14,856	12,177	8,037	4,871	4,140

Table 3.6-4. Estimated percent species composition of the total catch of finfishes taken in shrimp trawls for each of the six major species discarded in the inshore and offshore waters of the Gulf of Mexico between 87° 30' and 91° 30', 1973-1977 (data collected and summarized by the National Marine Fisheries Service, Pascagoula, Mississippi).

Year	Inshore						Offshore					
	Atlantic Croaker	Sand Seatrout	Spot	Sea Catfish	Atlantic Cutlassfish	Silver Seatrout	Atlantic Croaker	Sand Seatrout	Atlantic Cutlassfish	Spot	Silver Seatrout	Sea Catfish
1973	17.3	4.6	21.4	8.5	7.6	0.6	(2)	(2)	(2)	(2)	(2)	(2)
1974	46.2	2.6[1]	19.7	13.2	7.0	---	80.4	1.1	(3)	(3)	2.2	8.8
1975	36.2	12.9	7.7	7.0	6.3	2.1	56.2	6.3	6.2	1.9	1.6	11.8
1976	24.1	4.6	15.4	8.2	2.5	0.3	45.1	6.9	2.0	9.6	1.8	3.2
1977	16.9	9.8	16.7	5.0	5.1	0.3	23.5	6.1	5.1	14.1	(3)	6.3

[1]Includes Silver Seatrout.

[2]No data coverage.

[3]No records of having been captured.

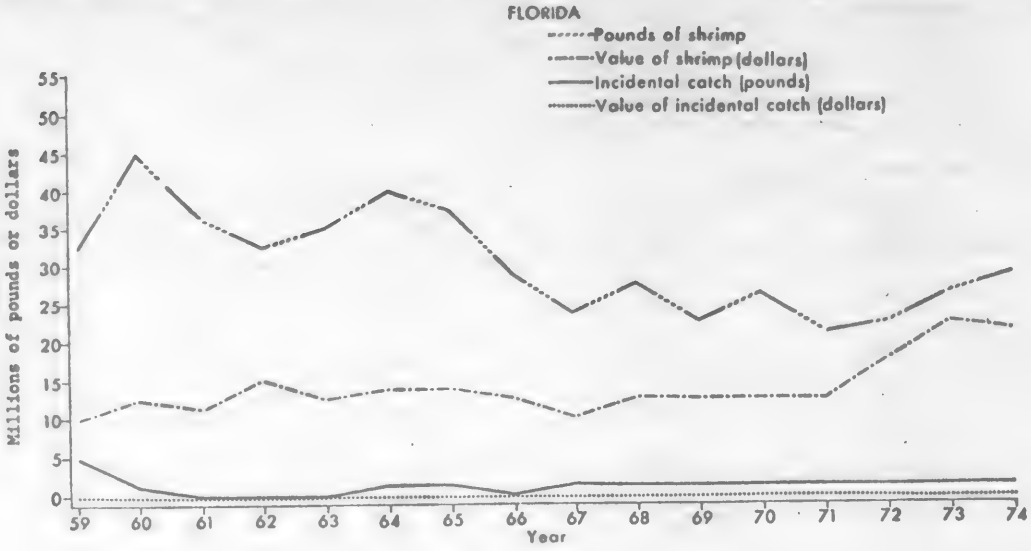


Figure 3.6-1. Annual Florida landings and value of shrimp and marketable incidental catch, 1959-1974. Poundages are in round (live) weight. Source: Fishery Statistics of the United States, 1959-1974.

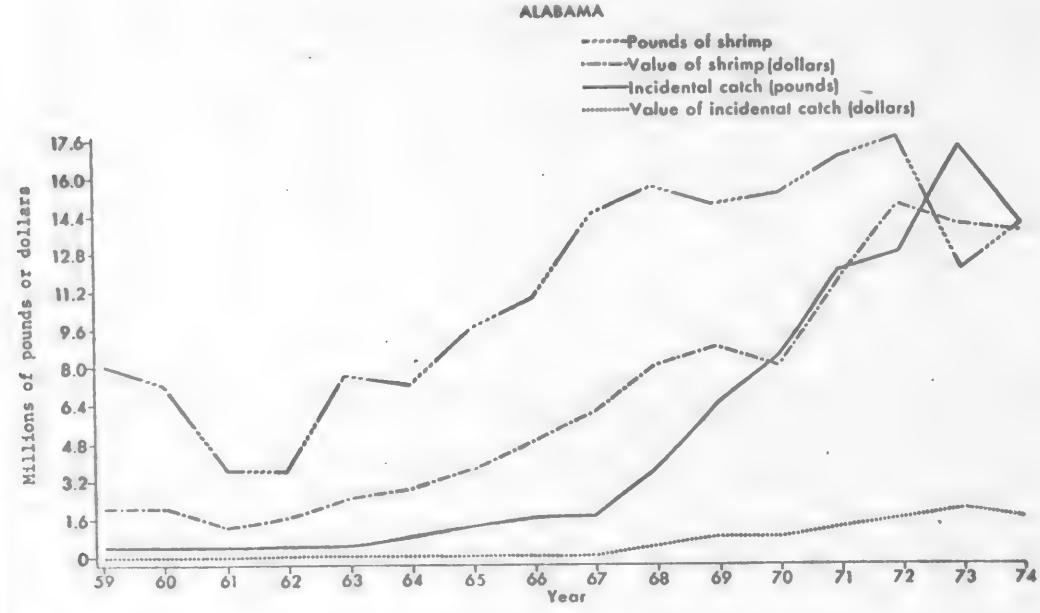


Figure 3.6-2. Annual Alabama landings and value of shrimp and marketable incidental catch, 1959-1974. Poundages are in round (live) weight. Source: Fishery Statistics of the United States, 1959-1974.

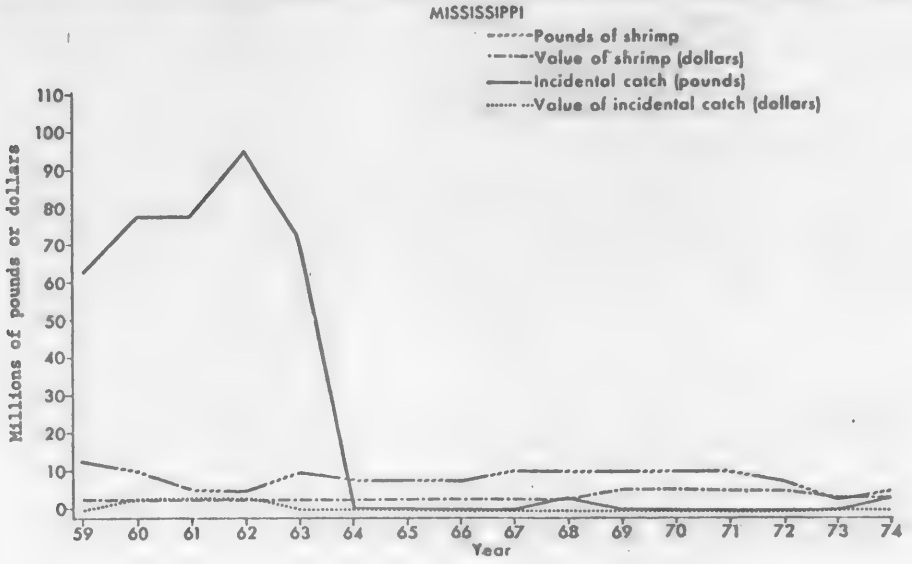


Figure 3.6-3. Annual Mississippi landings and value of shrimp and marketable incidental catch, 1959-1974. Poundages are in round (live) weight. Source: Fishery Statistics of the United States, 1959-1974.

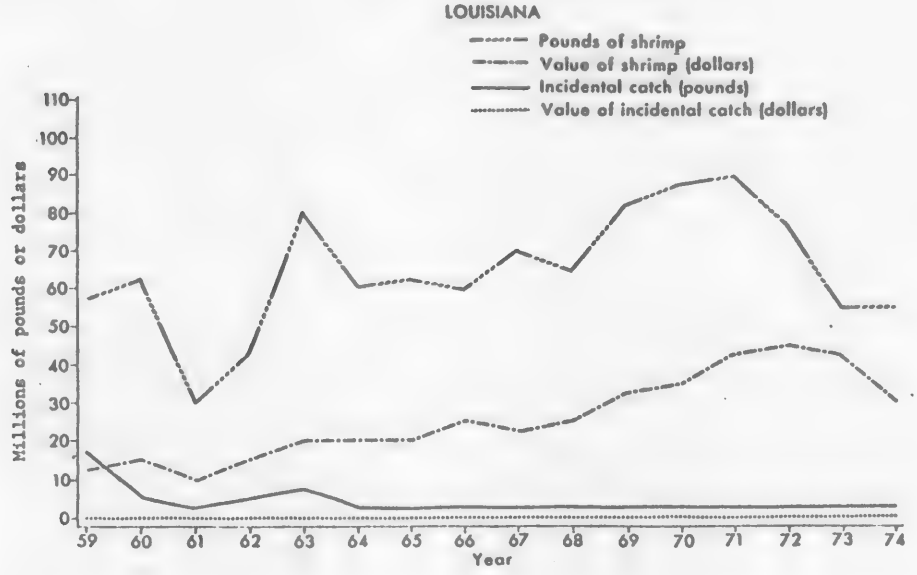


Figure 3.6-4. Annual Louisiana landings and value of shrimp and marketable incidental catch, 1959-1974. Poundages are in round (live) weight. Source: Fishery Statistics of the United States, 1959-1974.

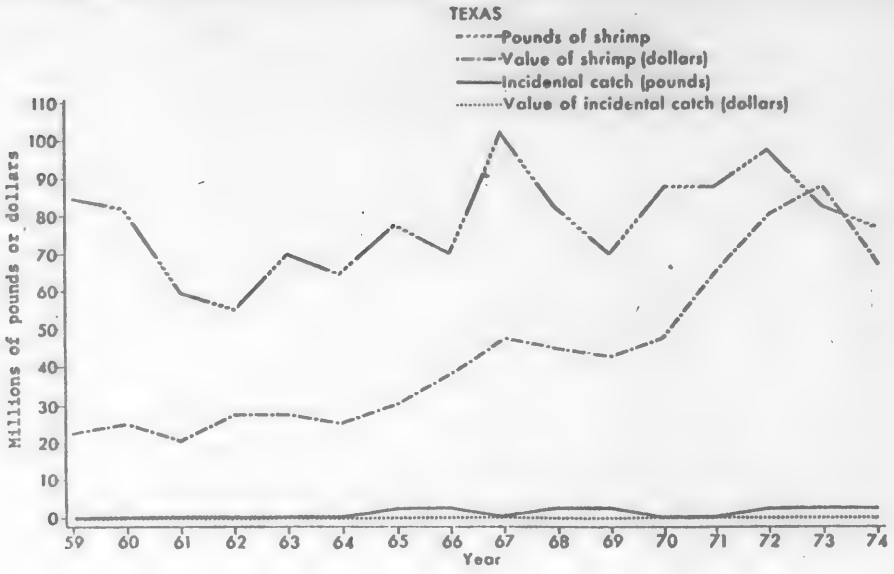


Figure 3.6-5. Annual Texas landings and value of shrimp and marketable incidental catch, 1959-1974. Poundages are in round (live) weight. Source: Fishery Statistics of the United States, 1959-1974.

BILLING CODE 3510-22-C

Of the sea turtles in the Gulf, the Kemp's ridley is in the greatest danger of extinction. Almost all of Kemp's ridley nesting is restricted to a small stretch of beach near Rancho Nuevo, Tamaulipas, Mexico, although nestings are also recorded for Padre Island on the Texas coast. Seventeen recaptures of tagged nesting females show that these ridleys are distributed throughout most of the Gulf. Eight—all taken by shrimp trawlers—occurred in 1969 between Brownsville, Texas, and the mouth of the Mississippi. Captures of Kemp's ridleys through the years are recorded from Brownsville to the Dry Tortugas off Florida: it is believed that these turtles migrate along the shores back to Mexico for nesting. One of the smallest sea turtles with a primary range in the Gulf of Mexico, the ridley is a turtle of coastal areas—primarily a carnivore and a bottom feeder.

The National Marine Fisheries Service and the U.S. Fish and Wildlife Service are currently involved in research and public workshops whose goal is to restore those sea turtle populations in a manner consistent with the requirements of the Endangered Species Act. Three approaches to reducing the incidental catch are most prominent: first, delineation of critical habitats and restriction of trawling in these areas; second, an education program to inform shrimpers and goundfish fishermen of the methods of, and reasons for, adequatley handling incidentally captured sea turtles in order to reduce mortality; and third, development of gear such as the excluder panel, which reduces the capture of sea turtles during trawling operations. Currently work is underway on all three approaches.

3.7 State and Federal Revenues Derived From Shrimp Fishery

State and federal revenue figures from the shrimp fishery are not isolated by data processing systems of the state agencies in the Gulf; these data are included, however, at the federal level with non-related activities.

The only available documentation applies to licenses and severance taxes imposed by the states. Revenues by states are listed below:

State	1977	1976	1975	1974	1973
Texas	$881,084	$845,556	[illegible]	[illegible]	$644,781
Louisiana	645,867	517,877	405,651	405,152	405,507
Mississippi	54,696	43,889	37,912	[illegible]	37,842
Alabama	[illegible]	25,846	19,017	17,099	16,218
Florida west coast	470,109	450,431	439,439	431,078	398,062

Such items as taxes paid for fuels, income, social security, and employment security by participants in the shrimp fishing effort do not appear in any statistical breakdown, nor is there any pinpointed material on government income derived from the onshore processing and distributing segment.

4.0 Biology Descriptors

4.1 Life History Features

General Features of the Speices

The general life cycles of brown, white, and pink species of shrimp are similar. Adults spawn in the Gulf. Fertile eggs hatch into free-swimming larvae, and the larvae pass through a series of molts. During the postlarvae stage, the shrimp enter an estuary and become bottom feeders.

Within the estuary the juvenile shrimp feed mainly at the marshwater or mangrove-water interface or in submerged grass beds. These areas apparently offer both a concentrated food supply of detritus, algae and microfauna and some protection from predators. Growth and survival in the estuary are largely dependent upon local salinity and temperature regimes. As they grow larger the shrimp shift to deeper waters and become more predacious. At a variable size 2.75–4.7 in (70 to 120mm) they emigrate to the Gulf. This emigration is a function of size, tide, and temperature. Growth continues at a rapid rate in the Gulf under optimum temperatures, though it declines as shrimp approach their maximum size. Spawning probably occurs before the shrimp are 12 months old.

Major differences in the life cycles of the brown, white, and pink shrimp are due to shifts in the time and space at which various life stages reach their maximum abundance. These shifts apparently allow the species to avoid direct competition even when one species predominates in the same general geographical area. In areas where shrimp stocks co-occur, management has built its harvest strategies around these shifts. For example, the Louisiana estuaries are closed in winter and early spring in order to protect juvenile brown shrimp. The inshore brown season is closed when appreciable numbers of juvenile whites appear in trawls for brown shrimp.

There are five overriding biological factors which seem to account for the resiliency of the shrimp resources:

(1) The migration of the life stages through several environments.

(2) The food habits of juveniles and subadults in the estuary provide access to rich, widely-based food supply.

(3) The apparent rapid growth rate of shrimp under favorable conditions results in a harvestable size shrimp within a short time.

(4) High fecundity and extended spawning seasons help to prevent recruitment overfishing in spite of intense fishing pressure.

(5) A large portion of the Gulf is inaccessible to harvesting, e.g., rocky bottom, loggerheads, etc.

The other three shrimp species exploited in the Gulf (royal red, seabob, and rock shrimp) are not estuarine-dependent and apparently spend their life cycles within the open waters of the Gulf. Royal red shrimp differ considerably from other species in that they: (1) Are harvested from depths of 100 to 300 fathoms, (2) have an estimated five year classes occupying the same fishing grounds, (3) exist in a relatively stable environment, and (4) do not reach sexual maturity as a zero-year class shrimp. Seabob shrimp are harvested, along with white shrimp, October through December when they migrate towards the Gulf beaches from deeper water, in response to advancing cold fronts. Rock shrimp are harvested mainly from Florida's sandy bottoms. They are taken primarily as bycatch.

Sexual Maturity

The minimum size at which shrimp become sexually mature (males—fully developed spermatophores; females—ripe ovaries) are listed in Table 4.1–1.

Spawning, Larval Development, Recruitment of Postlarvae to Either Estuaries or Fishing Grounds

Brown Shrimp

Renfro and Brusher (1965) found brown shrimp spawned in Gulf waters of greater than ten fathoms from spring to early summer and continuously at 25 to 60 fathoms. Two peaks were noted, a major one in September to November and a minor one April to June (Renfro and Brusher, 1965). A February to March spawning peak has been proposed (Gunter, 1950; Kutkuhn, 1962), based on

juvenile abundance in estuaries; however, no direct evidence was presented. Temple and Fisher (1967) note that off the Texas coast planktonic stages of Penaeus species were greatest at 14.8 fathoms from August to November and in 25.2 fathoms and 44.8 fathoms from September to November. They suggest that as these peaks corresponded to peaks in the occurrence of adult brown shrimp at these depths, the larvae were those of brown shrimp. The reported commercial catch peaks in July on the zero-year class; and spawning reaches its height after this July peak and occurs during the intense fall offshore fishing season for brown shrimp.

Baxter and Renfro (1967) found that postlarval brown shrimp recruitment to Galveston Bay peaks in March and mid-April. Second and third peaks are sometimes noted June through September. Estuarine recruitment may occur slightly earlier in Louisiana. White and Boudreaux (1977) and Gaidry and White (1973) report that postlarval brown shrimp recruitment normally peaks in Louisiana in February to March. Thus peak recruitment of postlarval brown shrimp to the estuaries occurs months after the peak in spawning.

Basing their claim on a comparison of their work with Baxter and Renfro (1967), Temple and Fisher (1967) proposed an overwintering of postlarval brown shrimp in the Gulf. They suggest that the postlarvae burrow in the offshore bottom and await the advent of warmer temperatures before entering the estuaries. In support of this theory they note the laboratory work of Aldrich, et al. (1967) which showed that postlarval brown shrimp burrowed at low temperatures.

White Shrimp

A single female white shrimp releases between 500,000 and 1,000,000 eggs in a spawn (Burkenroad 1934, Anderson, et al., 1949). Spawning occurs in Gulf waters at four to seventeen fathoms, spring through fall (Lindner and Anderson, 1956; Renfro and Brusher, 1964; Joyce, 1965; Bryan and Cody, 1975). The spring spawn is believed to be accomplished by females which have overwintered, while the fall spawn is largely attributed to females spawned in the early spring (Lindner and Anderson, 1956).

Multiple spawning of white shrimp in a single season is believed to occur (King, 1948; Lindner and Anderson, 1956; and Renfro and Temple, personal communication in Perez Farfante, 1969).

Off the Texas coast the greatest abundance of planktonic stage Penaeus species occurred from May to August at 7.6 fathoms (14 m) (Temple and Fisher, 1967). They suggest that this peak was composed of white shrimp and note that the time corresponded to the reported spawning peak for white shrimp.

Larval development requires between ten to twelve days (Johnson and Fielding, 1956) and two to three weeks (Anderson, et al., 1949). By the time the postlarval stage is reached, the shrimp have normally entered the estuarine nursery areas (Anderson, et al., 1949). However, Anderson, et al. (1949) reported that "schools of adult white shrimp have been known to approach the coast and spawn close to inlets. When such a spawning occurs, the eggs may be swept through the passes on incoming currents, and larvae (nauplii) may reach the nursery grounds within a few hours."

Table 4.1.1.—*Estimate of the minimum sizes at which shrimp reach sexual maturity (fully developed spermatophores for males and ripe ovaries for females)*

Species/sex	Size (total length, mm)	Source
Brown shrimp:		
Males	[1] 140	Renfro (1964).
Females	140	Renfro (1964).
White shrimp:		
Males	155	(Perez Farfante's [1969] conversion of Burkenroad's [1934] estimate).
Females	115	(Perez Farfante's [1969] conversion of Burkenroad's [1934] estimate).
Pink shrimp:		
Males	[illegible]	(Perez Farfante (1969).
Females	92	Eldred et al. (1961).
Royal red:		
Males	125	Anderson and Lindner (1971).
Females	155	Anderson and Lindner (1971).
Rock shrimp:		
Males	[illegible]	Cobb et al. (1973).
	42	Kennedy et al. (1977).
Females	49	Cobb et al. (1973).
	64	Kennedy et al. (1977).
Seabob:		
Males	([2])	
Females	63	Anderson (1970).

[1] Assumed.
[2] Not available.

Postlarval white shrimp recruitment to the estuaries of the northern Gulf occurs over a fairly uniform time period. In Mississippi it extends from May through October (Christmas, et al., 1966). In Louisiana, postlarvae are primarily recruited to the estuaries from July to August though recruitment begins in June (Gaidry and White, 1973; White and Boudreaux, 1977). In Texas, postlarval white shrimp recruitment to the estuary extends from May through October (Baxter and Renfro, 1967).

Pink Shrimp

Pink shrimp in the Dry Tortugas area spawn year round at 12 to 26 fathoms, with a more intense spawn in spring through fall (Ingle, et al., 1959; Cummings, 1961; Tabb, et al., 1962; Jones, et al., 1964, in Perez Farfante, 1969). In the Tampa and Apalachicola areas, spawning occurs in summer, and juveniles overwinter in the bays (Christmas and Etzold, 1977). Matosubrato (1974) estimates fecundity at about 500,000 eggs per female.

Minimal larval development time is 15 days (Ewald, 1965; Jones, et al., (1964). In the Dry Tortugas, estuarine recruitment is continuous, with peaks in abundance reported for April to June (Tabb, et al., 1962) and July through October (Jones, et al., 1964). A May through December recruitment of pink shrimp in Mississippi is reported (Christmas, et al., 1966). In Texas, Copeland and Truitt (1966) report an August to September peak in recruitment.

With the three major species, copulation is not directly associated with spawning. Indeed, Perez Farfante (1969) suggests multiple copulation for white and pink shrimp, since female white shrimp often lost the attached spermatophore and female pink shrimp shed the spermatophore upon molting.

Royal Red Shrimp

Anderson and Lindner (1971) observe that the St. Augustine population of royal red shrimp have a major spawning peak during the winter and spring, with some spawning occurring throughout the year. Their analysis of length-frequency distributions by sex for all sample periods combined suggests that recruitment to the fishery begins at one year of age but is not complete until the shrimp reach maturity at about three years of age. They note that the majority of shrimp taken in their samples were fully mature. Even though this population is outside of the management area, this information is thought to be true of the Gulf of Mexico stock.

Rock Shrimp

Spawning of rock shrimp in Gulf waters off Tampa to Fort Myers, Florida, is continuous, with a peak in October through January (Cobb, et al., 1973). Development time to postlarvae requires 29 days in the laboratory at 70° to 76° F (21° to 24.5° C) and 24 to 27 ppt (Cook and Murphy, 1965).

Cobb, et al., (1973) note that rock shrimp less than 1.2 in. (30 mm) total length appeared in their samples in March, May to July, and November, whereas slightly larger individuals occurred in all other months except

December. They therefore suggest recruitment to the fishing grounds occurs year round.

Rock shrimp are not believed to be estuarine dependent (Eldred, 1959; Joyce, 1965; Cobb, et al., 1973). Cobb, et al., (1973) suggest that the shrimp found by Rouse (1969) in Chatham River, Florida, were other species of Sicyonia and not rock shrimp. The life cycle of rock shrimp is apparently passed in offshore waters and mainly at depths of 10 to 45 f (18 to 82 m) (Cobb, et al., 1973).

Seabob Shrimp

Juneau (1977) reports gravid seabob females were taken in peak numbers along the Louisiana beaches in July and August, while smaller non-gravid females were taken in large numbers between December and March. He concludes that spawning most likely occurs in the Gulf between July and December.

Renfro and Cook (1963) observe that early larval development from spawning to first protozoeal stage requires 58 hours in the laboratory at 73–75° F (23° to 24° C) and 27 ppt.

Juneau (1977) reviews current information available on seabob shrimp and concludes with Renfro and Cook (1963) that the species is probably not estuarine dependent and is found most commonly from the beach line to Gulf waters of five fathoms (9 m) and are primarily caught in one to two fathoms (1.8 to 3.6 m) along the Louisiana coast (within the Territorial Sea).

Emigration of Brown, White, and Pink Shrimp From Estuaries

The time, size, and causes of emigration have important management implications for brown, white, and pink shrimp. The specific reasons for their importance may vary from area to area. In Louisiana, with its large inshore harvester group, the setting of opening dates must include a recognition that a portion of the catch may be lost for smaller boats if the shrimp emigrate before the inshore season is opened. Conversely, in Texas and southern Florida where estuarine and near-shore Gulf harvest is restricted, the expected emigration time is needed in order to close offshore waters to protect the emigrating crop.

In general, emigration is keyed to environmental conditions such as tides, temperature, or salinity. Fishermen take advantage of this knowledge and fish the surface waters of channels and passes with a butterfly, or wing net used at night, although efforts during the day are sometimes rewarded.

Brown Shrimp

Copeland (1965) sampled ebb tide March to December in Aransas Pass, Texas. He found that brown shrimp emigration peaked in association with full moons in May through August, the high tides and faster currents of full moons being a stimulus to emigration.

Trent (1967) sampled the main tidal pass to Galveston Bay, day and night on the ebbing tides (May to August) with a bottom trawl as well as from June to August with a surface trawl. Catch per unit effort was greater on the bottom during the day and at the top during the night, though the difference was not significant.

Trent (1967) found two peaks in abundance of emigrating shrimp: one in mid-May and another in mid-June. The mean size of emigrating shrimp increased linearly from 400 tail count (58 mm) on May 18 to 40 tail count (108 mm) on July 28 or 0.14 in. (3.6 mm) per week. (See Table 4.1.5 for length-weight conversions).

Gaidry and White (1973) observed that emigration of brown shrimp from the Louisiana nursery grounds occurs in two stages. The first movement normally begins at a size of 264 to 415 tail count (60 to 70 mm) when juveniles leave the shallow marsh areas for the open bays. These bays serve as a "staging area" where the shrimp continue to grow and feed until they begin a second movement—the migration to offshore waters—at a size of 3.5 to 4.3 in (90 to 110 mm). This offshore movement begins in middle to late May, increases in intensity in June and July, and continues in diminished magnitude until November when essentially all the shrimp have left the bays.

Blackmon (1974) sampled a small tidal pass in Caminada Bay, Louisiana, from May to November on the full and new moons. He found that the mean length of emigrating shrimp generally increased from 3 in. (79 mm) in May to 3.8 in. (98 mm) in September and then declined to 3.3 in. (84 mm) in November. Mean lengths of emigrating shrimp were always greater than those in the bay: during the May to September period, the average emigrating shrimp was at least 0.39 in. (10 mm) larger than its average counterpart in the bay.

The highest percentage of emigrating brown shrimp occurred during or just after twilight. No correlation was found between the percentage of emigrating shrimp and current speed, temperature, or salinity. Distribution of emigrating shrimp in the three-meter water column changed with time of day. During the day, peak density of emigrating shrimp was greatest on the bottom; at twilight, the peak occurred in the middle; and at night, the peak occurred in the top meter (Blackmon, 1974).

White Shrimp

White shrimp that enter the Louisiana estuaries as postlarvae in the spring and early summer emigrate to the Gulf in September through November (Gaidry and White, 1973). Those white shrimp postlarvae recruited to the estuary later in the summer and early fall may be forced offshore by advancing cold fronts in October to December at a size much smaller than that of shrimp emigrating in the summer. These "later-recruited" white shrimp overwinter in the nearshore Gulf and reenter the estuaries at an average size of 100 mm during the spring warming. After a second period of growth, they emigrate to the Gulf to spawn in the spring and early summer (Lindner and Anderson, 1956; Gaidry and White, 1973).

Pink Shrimp

In the Everglades nursery areas, Yokel, et al., (1969) observed that juvenile pink shrimp emigrate almost exclusively at night, and on night ebb rather than night flood tides. Catch per unit effort of emigrating was 37 shrimp per minute as during new and full moons opposed to 20 shrimp per minute during the first and third lunar quarter. The effect of moon phase was directly dependent upon the relative abundance.

They observed that the size of emigrating shrimp ranges from 2 to 45 mm (carapace length), and averaged 14 mm (carapace length). Using Kutkuhn's (1966, Fig. 7) carapace length vs. weight plot for pink shrimp, the size range equates to a weight range of up to 80 g for male shrimp and an average of 2.0 to 2.5 g for male and female shrimp. The average shrimp leaving the Everglades is in the 300 to 200 tails to the pound range.

Migration Patterns in Offshore Waters

Brown Shrimp

Brown shrimp released off the Mississippi coast in June (Klima and Benigno, 1965) traveled less than an average of one mile per day from the release site. An offshore movement was not apparent since less than one percent of returns came from waters deeper than 16 fathoms. The longest distance traveled was 85 miles—from the release site off Horn Island to the Mississippi River's Southwest Pass. This information indicates that the Mississippi River may not be an absolute barrier to brown shrimp migration.

Most of the brown shrimp released off Grand Isle, Louisiana, in July (Klima,

1964) were recaptured near the release site. A slight seaward and westward movement was noted.

Movement of brown shrimp released off Galveston, Texas, in July led Klima (1964) to suggest that brown shrimp from the Galveston estuary were recruited to the fishery all along the Texas coast.

Brown shrimp released off the central Texas coast at 21 to 24 fathoms in April (Klima, 1964) showed little coastwide movement. No major offshore movement was apparent from April to June because 99 percent of the returns were within 25 fathoms and none were beyond 30 fathoms.

From an examination of commercial catch trends, Gunter (1962) suggested a southward drift of brown shrimp off the Texas coast in the fall.

The commercial catch statistics indicate that brown shrimp migrate out to the deeper waters of the Gulf. The inshore catch peaks in May to July on shrimp smaller than those measuring 67 tails to the pound. After Texas opens its Territorial Sea, offshore brown shrimp catch in the Gulf as a whole peaks in July and August at depths of 11 to 20 fathoms, with most of the landed shrimp being 31 to 40 tails to the pound. By December, the largest catch comes from 26 to 30 fathoms, and the 15 to 20 tails to the pound shrimp perdominate. Generally, the data indicate a four to five fathom per month depth migration of the catch. However, the relationship of the shift in the catch to the actual depth migration of the shrimp is somewhat obscured by the Texas closure in June and mid-July and by the multiple waves of shrimp emigrating from the estuaries.

White Shrimp

White shrimp east of the Mississippi River to Mobile Bay tend to migrate from the estuaries to deeper waters along the barrier islands and towards the Mississippi River Delta during the summer to fall (Lindner and Anderson, 1956). The Mississippi River may act as a barrier to east-west movement (Lindner and Anderson, 1956; Perez Farfante, 1969).

Other than the offshore-onshore migrations and a tendency to concentrate between Ship and Trinity Shoals, Lindner and Anderson (1956) observed no definite migration patterns of white shrimp along the Louisiana coast west of the Mississippi River during the fall and winter.

Klima (1964) noted a coastwide movement or dispersion of tagged white shrimp along the Louisiana coast between Cameron and Vermillion bay. Perret, et al., (1978) observed that movement along the western portion of the Louisiana coast was mainly westerly, though the majority of the tagged shrimp were returned within 60 nautical miles of the release area.

Lindner and anderson (1956) observed a migration of white shrimp from off the coast of Mexico to Aransas Pass, Texas, during the spring. There also appears to be a reciprocal southward movement from central and southern Texas into northern Mexico during the fall and winter. From an analysis of reported commercial catch patterns, Gunter (1962) suggested a similar southward movement of white shrimp.

Pink Shrimp

Juvenile pink shrimp emigrate from the estuaries of southern Florida into the deeper waters of the Gulf. Costello and Allen (1965) found that the nursery grounds of pink shrimp on the Tortugas grounds were estuaries from the Florida Bay and from at least as far north as Indian Key, whereas the nursery grounds of shrimp on the Sanibel grounds were estuaries from at least Indian Key north to Pine Island Sound. They observed little movement of shrimp between the Tortugas and Sanibel grounds. Iverson, et al., (1960) observed that larger pink shrimp tended to occur at deeper depths on the Tortugas grounds.

Royal Red and Rock Shrimp

Apparently nothing is recorded about migration patterns of royal red or rock shrimp.

Seabob Shrimp

Immediately following passage of a cold front, seabob shrimp along the Louisiana coast migrate toward the beach from offshore areas. In July and August, gravid females also move close to shore (C. J. Juneau, personal communication in Christmas and Etzold, 1977).

Substrate

The substrate preferences of shrimp appear to be important to their distribution patterns along the Gulf coast. In general, pink and rock shrimp prefer calcareous sediments and are found mainly along the Florida coast. Brown, white, and seabob shrimp prefer soft mud or peat bottoms and are found mainly along the coast from Texas to Alabama.

The juvenile brown and white shrimp prefer a soft mud or peat bottom with large quantities of decaying organic matter or vegetation (Williams, 1955, 1959; Mock, 1967; Jones, 1973). Sand or clay substrates are sometimes satisfactory for young brown shrimp, unless these substrates are bare clay, sand, or shell (Williams, 1959). Adult brown shrimp are found on mud or silt and also on mud, sand, and shell (Perez Farfante, 1969). In the Gulf, white shrimp are also found on muddy or sility bottoms and on clay or sand with fragments of shell (Springer and Bullis, 1954; Hildebrand, 1954, 1955).

Pink shrimp apparently prefer firm mud or silt bottoms with coral sand containing a mixture of millusk shells (Springer and Bullis, 1954; Hildebrand, 1954, 1955; Williams, 1958) and firm sand bottoms (Farfante, 1969).

Royal red shrimp show not apparent preference for a particular sediment type; they occur on sand, silty sand, terrigenous, and calcareous sediments (Roe, 1969).

Rock shrimp occur most frequently on sandy bottoms (either terrigenous or biogenic) and only sporadically on mud bottoms (Hildebrand, 1954, 1955; Cobb, et al., 1973). Hildebrand (1955) suggests bottoms were "strays" from areas of hard sand. In South Carolina, the rock shrimp is called the coral shrimp because it is occasionally taken from coral banks (Lunz, 1957).

Seabob shrimp are taken from bottoms and mud, silt, or silt mixed with sand (Neiva, 1967; Christmas and Etzold, 1977).

Food

Larval Stages

Larval stages are planktonic and eat algae and zooplankton (Pearson, 1939; Ewald, 1965). Nutrient levels of Gulf waters may be a necessary environment for larval stages because a high density of food causes poor survival due to entanglement.

The postlarval stage is not strictly planktonic but is capable of deposit feeding (Pearson, 1939). Zien-Elden and Griffith (1969) have fed this stage on algae, *Artemia salina* nauplii, and groundfish or shrimp in the laboratory.

Juveniles to Adults

Juvenile and adult brown, white, and pink shrimp ingest whatever is available, including decaying organic matter, animals, and plants (Vicosa, 1920; Weymouth, et al., 1955; Flint, 1956; Darnell, 1958; Broad, 1965; Perez Farfante, 1969; Odum, 1971; Jones, 1973).

Jones (1973) intensively studied the food habitats and absorption efficiency of brown shrimp 1 to 4 in. (25 to 104 mm) in a Louisiana marsh. He observed a shift in diet and habitat as shrimp grew larger. Juveniles 1 to 1.75 in. (25 to 44 mm) were concentrated in the nearshore environment. Here they indiscriminately ingest the top layer of sediment containing detritus and microorganisms.

Jones classified this stage as omnivores or encounter-feeders. At 1.8 to 2.5 in. (45 to 64 mm) they selected the organic fraction of the sediment and were classified as opportunistic omnivores. At 2.6 to 4 in. (65 to 104 mm) shrimp had dispersed from the nearshore environment to the deeper waters of the marsh and became active predators feeding intensively on polychaetes, amphipods, nematodes, and chironomid larvae. However, they continued to ingest detritus and algae and were classified as omnivore predators (Jones, 1973).

Darnell (1958) found the foreguts of white shrimp 3.6 to 5.6 in. (91 to 142 mm) contained sand, detritus and ground organic matter, and fragments of mollusks, ostracods, copepods, insect larvae, and forams.

Eldred, et al., (1961) found pink shrimp in the Tampa Bay contained both animals and plant remains. These include aquatic macrophytes, red and blue-green algae, diatoms, dinoflagellates, polychaetes, nematodes, shrimp, mysids, copepods, isopods, amphipods, mollusks, forams, and fish.

Rock shrimp are apparently nocturnal, generalized carnivores (Cobb, et al., 1973). Small bivalve mollusks, decopod crustaceans, gastropods, and other crustaceans are an important part of the diet which also includes formaminfera, nematodes, polychaetes, ectoprocts, echinoderms, and finfish (Cobb, et al., 1973; Kennedy, et al. 1977).

Nothing is apparently recorded on the food habits of seabob or royal red shrimp.

Predation

Penaeid shrimp, in general , are ingested by many carnivorous fish (Gunter, 1945; Darnell, 1958; Farfante, 1969). Table 4.1–2 list some fish known to ingest brown, white, or pink shrimp. Included in this list are speckled trout, black drum, redfish, Atlantic croaker, southern flounder, bass, and several varieties of catfish. Many of these prey species are an important component of the bycatch discarded by shrimpers.

Growth Rates

General Considerations

As in most fisheries, growth rates are estimated from changes in the length of the species with time. Growth in weight is estimated by converting growth in length estimates to weight. Table 4.1–3 lists length-weight estimates for shrimp.

The method of measuring growth varies with the size of shrimp. Growth (in length) of "smaller" shrimp 1 to 3.5 in. (25 to 90 mm) is normally estimated from length frequency measurements of trawl samples taken in estuarine nursery areas over a period of time. Growth is expressed as the increase either in the mean size of the trawl sample or in each of the peaks in the polymodal length-frequency data with increasing time. Growth estimates range from 0.003 to 0.13 mm) per day. Variability has been attributed to temperature, salinity, recruitment, density, and emigration.

Growth of "large" shrimp greater than 2.75 in. (70 mm) has normally been estimated from mark and recapture experiments. A simple linear relationship of length (or weight) to time is not applicable. The shrimp enter a self-limiting period of growth.

Table 4. 1-2.—*Fish identified by Gunter (1945) or Darnell (1958) as feeding on penaeid shrimp*

Species	Common names
Carcharhinus leucas (Miller and Henle).	Bull shark.
Dasyatis sabina (LeSueur)[1]	Stingaree.
Lepisosteus spatula (Lacepède).	Alligator Gar.
Elops saurus (Linnaeus)	Bonefish, Shipjack, Bigeye Herring, Ten-pounder.
Ictalurus furcatus (LeSueur)	Blue catfish.
Bagre marina (Mitchell)	Gafftopsail catfish.
Galeichthys felis (Linnaeus)	Hardhead or sea cat.
Morone interrupta (Gill)	Yellow bass.
Micropterus s. salmoides (lacepede)[3].	Northern largemouth bass.
Sciaenops ocellate (Linnaeus).	Redfish, channel drum.
Micropogon undulatus (Linnaeus).	Atlantic croaker.
Pogonias Cromis (Linnaeus)[2]	Black drum.
Cynoscion neulosus (Culver and Valenciennes)[3 4].	Speckled trout.
Parlichthys lethostigma (Jordan and Gilbert).	Southern flounder.

[1] Assumed to ingest shrimp by Darnell (1958).
[2] Darnell (1958) states that when black drum are in the marine waters Gulf penaeid shrimp are a significant portion of its diet.
[3] Gunter (1945) states that in Texas shrimp are the predominant food of speckled trout during the summer. However, when shrimp are scarce, as in January speckled trout shift to fish (*Mugil* species).
[4] Darnell (1958) states that pink shrimp are the stable diet of speckled trout in Florida.

BILLING CODE 3510-22-M

Table 4.1-3. Length-weight relationships for brown, white, pink, royal red, and rock shrimp (after Christmas and Etzold 1977).

Species/Sex	Total Length to Total Weight: $W = a L^b$ a	b	Size Range (mm)	No. measured	Carapace Length to Total Weight: $W = a' C^b$ a'	b	Size Range (mm)	No. measured	Carapace Length to Total Length: $Log'' C^b$ a''	b	Size Range (mm)	No. measured	Source
	x 10^{-6}												
Brown shrimp													
Combined	12.3	3.01	65-165	2104									McCoy (1968)[1]
Male	11.61	2.911	65-204	1396									Fontaine and Neal (1971)
Female	9.53	2.966	55-240	2016									Fontaine and Neal (1971)
Combined	10.52	2.938	45-240	3412									Fontaine and Neal (1971)
Male					0.000818	2.94	10-41	259	(2)				McCoy (1972)[1]
Female					0.00113	2.84	10-41	243	(2)				McCoy (1972)[1]
White shrimp													
Combined	7.69	2.976	55-160	100									Perret (1966)
Male	2.02	3.261	70-200	870									Fontaine and Neal (1971)
Female	2.32	3.234	70-214	1120									Fontaine and Neal (1971)
Combined	2.16	3.247	70-214	2090									Fontaine and Neal (1971)
Pink shrimp[3]													
Male	4.49	3.13	35-175	729	0.001[4]	3.04	8-40	729	5.27	0.96	35-175	729	Kutkuhn (1966)
Female	5.06	3.12	35-215	888	0.002[4]	2.79	8-53	888	6.14	0.90	35-215	888	Kutkuhn (1966)
Combined	9.79	2.98	65-165	2641									McCoy (1968)[1]
Male	10.01	2.967	70-175	1173									Fontaine and Neal (1971)
Female	5.93	3.92	60-114	1111									Fontaine and Neal (1971)
Combined	7.71	3.029	60-175	3298									Fontaine and Neal (1971)
Combined					0.0061	3.03443	6-22						Tabb, et al. (1962a)
Male					0.00148	2.77	10-42	297	(2)				McCoy (1972)[1]
Female					0.00209	2.66	10-41	503	(2)				McCoy (1972)[1]
Royal red shrimp:													
Dry Tortugas Area													
Male	2.129	3.22	113-154	109									Klima (1969)
Female	16.134	2.81	95-209	118									Klima (1969)
Combined	7.860	2.96	95-209	227									Klima (1969)
Mississippi River Delta Area													
Male	4.325	3.06	125-174	98									Klima (1969)
Female	13.306	2.83	135-229	114									Klima (1969)
Combined	5.853	3.00	125-229	204									Klima (1969)
Rock shrimp[6]													
Male					[illegible]	3.122	n.a.	n.a.					Cobb et al. (1973)
Female					[illegible]	3.144	n.a.	n.a.					Cobb et al. (1973)
Combined					0.000604	3.128	3-37	973					Cobb et al. (1973)

[1] For shrimp from North Carolina.

[2] McCoy (1972) derived the following equations for converting carapace length (CL) to total length (TL) in mm for North Carolina populations of:

Brown shrimp	Male	TL = 3.50 + 4.16 CL
	Female	TL = 10.50 + 3.83 CL
Pink shrimp	Male	TL = 12.37 + 3.81 CL
	Female	TL = 21.90 + 3.40 CL

[3] Iverson and Idyll (1960) provide conversion tables for pink shrimp in terms of total length, carapace length, and tails to the pound.

[6] Kennedy, et al. (1977) give the following relations for rock shrimp off the east coast of Florida:

Carapace length versus weight:	<23 mm CL	>23 mm CL	Carapace length versus total length:	<20 mm CL	>20 mm CL
Males:	$W = 4.104 \times 10^{-6} CL^{3.303}$	W = 1.886 CL - 30.922	Males:	TL = 3.803 CL + 0.249	TL = 3.448 CL + 7.523
Females:	$W = 3.398 \times 10^{-6} CL^{3.364}$	W = 1.818 CL - 30.475	Females:	TL = 3.786 CL + 0.118	TL = 2.881 CL + 18.498

where CL and TL are carapace and total length in mm and W is weight in gms.

[4] Kutkuhn's carapace-weight equations do not fit his published data, evidently due to rounding error. It is suggested that figures published in Kutkuhn (1966) be used instead of these equations to convert carapace length to weight.

BILLING CODE 3510-22-C

Brown Shrimp

Growth in length is slow 0.019 in. (0.5 mm per day) during January and February, increases in March, and reaches a maximum .02–.13 mm per day) in April and June (Loesh, 1965; Ringo, 1965; St. Amant, et al., 1966; Broom, 1968; Ford and St. Amant, 1971; Jacob, 1971; Swingle, 1971). This monthly variation in growth rate has been associated with the spring warming of the estuaries (St. Amant, et al., 1962; Ford and St. Amant, 1971).

Parrack (1978) estimates growth rate of brown shrimp from mark and recapture experiments conducted in the northern Gulf of Mexico in 1967, 1968, and 1969 (Clark, Emiliani, and Neal, 1974). His discussion indicates that females grow more rapidly than males, weigh more than males of the same age, and attain a larger final length and weight than males.

White Shrimp

Growth rates of white shrimp estimated from trawl samples range from .02–.08 in. (0.6 to 2.2 mm) per day in the summer (Williams, 1955; Gunter, 1955; Loesch, 1965).

Growth rates of white shrimp have been estimated by a number of workers from mark and recapture experiments. Lindner and Anderson (1956) marked white shrimp 200 to 18 tail count (5 to 180 mm) in the South Atlantic and northern Gulf and calculated formulae for growth in length and weight. The results indicated that growth in length was a function of size and month, growth being faster for the smaller than the larger shrimp, and faster in April to June and September to December than from December to March. Klima (1964, 1974) calculated formulae for growth in length and weight. In comparing growth rates for two time periods, he notes that growth was faster in August to October than in September to November. He suggests that the difference is due to differences in water temperature.

Pink Shrimp

Higman, et al. (n.d.) determined the growth of postlarval-juvenile pink shrimp held in enclosures in the estuarine area of Everglades National Park. Multivariant regression analysis was used to determine significant relationships between weekly growth rate estimates and weekly estimates of bottom salinity, temperature, and dissolved oxygen. Salinity appeared to be the most important factor. Since the salinity regime of this area is dependent upon drainage through southern Florida into the Everglades, pink shrimp success in the Dry Tortugas may be related to local rainfall in the Everglades drainage basin as well as to man-made alterations which block the normal waterflow patterns.

Several growth estimates from tagging experiments are available. Iverson and Idyll (1960) tagged pink shrimp in the Dry Tortugas in December, 1957, and recovered them through April, 1958. Females increased in weight from 39 to 31 tails per pound in 45 days, whereas males increased from 60 to 50 tails per pound in the same time. This approximates a growth rate of .07 oz. (0.75 g) per week for female shrimp and of .013 oz. (0.38 g) per week for male shrimp. The authors caution that these estimates were made in the "unusually cold winter of 1957–1958 and may be slower than the growth in a more normal winter." Kutkuhn (1966, table 4) estimates that pink shrimp tagged in the Dry Tortugas area September to December 1961 grew from 5.9 g to 19.5 g in 12 weeks. Lindner (1966) also derived growth curves for pink shrimp in the Dry Tortugas.

Royal Red and Seabobs

Apparently nothing is recorded about the growth rates of seabobs and royal red shrimp.

Mortality Rates

The death of fish in a population is due either to natural causes or to harvest by man. Coefficients of fishing (F), natural (M), and total (Z) mortality are defined as instantaneous death rates for a cohort of N individual fish over a short time, noted as dt. The rate of decline of the population numbers over time is presented as a function of these observed values.

The reported estimates of natural (M), fishing (F), and total (Z) mortality of shrimp are compared in Table 4.1–4. Values of the weekly natural mortality coefficient range from .01 to .55 or a loss of from 1 to 42 percent of the population from the beginning to the end of the week. Estimates of fishing mortality range from .02 to .96. The variations in mortality estimates make it difficult to construct yield per recruit models.

Yield Per Recruit

The pounds of brown, white, or pink shrimp which can be harvested from a given number of post-larval shrimp reaching an estuarine system is a function of the population's rates of growth and mortality, age at which harvest begins, and the rate of fishing mortality once the shrimp are subject to harvest. The age at which yield will be maximized will be dependent on the trade-off between growth and natural and fishing mortality.

Brown Shrimp

There are no published yield per recruit estimates available on brown shrimp. M. Parrack (NMFS, Galveston Lab) prepared a preliminary yield per recruit analysis using his sex specific growth rate equations for brown shrimp (Parrack, 1978) and two levels of monthly instantaneous natural mortality rate, M=.05 and M=.10 (Annon, 1978). (These levels of M on a monthly basis compare to estimate of M=.011 and .023 on a weekly basis.) If M=0.5, yield was maximized when harvesting began on shrimp six months of age, or 21 tails to the pound (assuming a sex ration of 50:50). If M=.10, yield was maximized when harvesting began on shrimp five months of age, or 24 tails to the pound (assuming a sex ratio of 50:50).

He points out that these sizes are much larger than size limits currently imposed in the U.S. Gulf. His analyses indicate that if the above estimates of M approximate reality and if F is at the level estimated by Berry (1971), then current harvesting strategies employed in the Gulf result in a harvest considerably below the theoretical maximum. Klima and Parrack (1978) review the question of the size of shrimp at harvest which will maximize yield and state that "data on hand indicates that these two rates (growth and natural mortality) balance at 6–9 months of age or at a size of 20–30 shrimp tails per pound." If their analyses are correct, then a reduction in the size at first harvest of brown shrimp in the U.S. Gulf of Mexico would result in a decrease in protein yield. Further, an increase in yield is expected if the size at first harvest of brown shrimp is increased in any of the areas of the U.S. Gulf.

White shrimp

Data are insufficient at this time to estimate the expected yield per recruit for white shrimp in the U.S. Gulf.

Pink Shrimp

The most extensive published yield per recruit estimates of Gulf shrimp are for pink shrimp off southeastern Florida (Kutkuhn, 1966; Lindner, 1966; Berry, 1971). Although there is some disagreement between authors, the data indicate that a reduction in yield will be expected if pink shrimp are harvested before they reach a size of 70 tails to the pound.

Table 4.1-4.—*Comparison of instantaneous rates of mortality (in weekly values) for shrimp in the U.S. Gulf of Mexico (modified from Berry 1970)*

Species	Natural mortality M	Fish mortality F	Total mortality	
Brown shrimp.	0.21	0.06	0.27	Klima (1964).
White shrimp.	.08	.06–.19	.14–.27	Klima and Berrigno (1965).
	.04–.12	.10–.13	.16–.22	Klima (1974).
	.27	.09	.36	Iverson (1962).
Pink shrimp	.55	.96	.76–1.51	Kutkuhn (1966).
	.06–.12	.12–.18	.25	Lindner (1966).
	.05–.06	.16–.23	.22–.27	Berry (1967).
	.08–.11	.03–.07	.11–.18	Costello and Allen (1966).
	.01–.03	.02–.16	.07–.16	Berry (1970).

Table 4.1-5.—*Length-Weight Conversion Table for Brown, White, Pink, and Royal Red Shrimp (Sexes Combined). (Equations are listed in Table 4.1-3)*

Total length	Count (per pound)							
	Brown shrimp[1]		White shrimp[2]		Pink shrimp[1]		Royal red shrimp[3]	
	Shrimp	Tails	Shrimp	Tails	Shrimp	Tails	Shrimp	Tails
Millimeters:								
50	440	708	[4]519	[4]766	[4]420	[4]673	(4)	(4)
60	258	415	301	464	242	387	(4)	(4)
70	164	264	227	349	152	243	[4]	[4]
80	111	178	147	227	101	162	137	247
90	78	126	100	155	71	113	97	174
100	57	92	72	110	52	83	71	128
110	43	70	52	81	39	62	53	96
120	34	54	40	61	30	47	41	74
130	26	43	31	47	23	37	32	58
140	21	34	24	37	18	30	26	47
150	17	28	19	30	15	24	21	38
160	14	23	16	24	12	20	18	32
170	12	19	13	20	10	16	15	26
180	10	16	11	16	[4]9	[4]14	12	22
190	9	14	9	14	(4)	(4)	10	19
200	7	12	8	12	(4)	(4)	9	16
210	6	10	6	10	(4)	(4)	8	14

[1] From Fontaine and Neal (1971).
[2] 50-60 mm estimates from Perret (1966) and 70-210 mm estimates from Fontaine and Neal (1971).
[3] Klima (1969).
[4] Outside of data range.

Temperature and Salinity

Temperature and salinity are important driving forces in the life cycles of brown, white, and pink shrimp, affecting growth, mortality, migration, and spawning. These factors can be incorporated in models used to predict annual yield (see Section 4.7.1.2).

The major influx of postlarval brown shrimp to the estuaries of the northern Gulf occurs February to March (Baxter, 1963; Baxter and Renfro, 1967; Gaidry and White, 1973; Christmas and Etzold, 1977). Little growth is expected until water temperature exceeds 20° C (St. Amant, et al., 1963; Ford and St. Amant, 1971).

Postlarval white shrimp normally enter the major bays of the Gulf when temperature are above 25° C (Baxter and Renfro, 1967) and are apparently optimum for growth and survival. As the temperatures decline in the fall with advancing cold fronts, growth apparently also declines (Lindner and Anderson, 1956; Klima, 1974). Annual production in the northern Gulf has been associated with estuarine salinity regimes. A similar salinity effect, caused by different weather patterns seems to operate in Texas and Louisiana. Gunter and Edwards (1969) observed a positive correlation between the annual successes (1922–1964) of white shrimp in Texas with the rainfall in the State for that year and the two previous years. They suggest that the lag effect of rainfall was a result of the arid conditions of the State. In Louisiana, an inverse relationship between annual white shrimp catch and the annual discharge of the Mississippi and Atchafalaya Rivers has been noted (Barrett and Gillespie, 1973). White and Boudreaux (1977) obtained statistically significant linear regressions of catch against river discharge by dividing the data into two periods, 1958–1968 and 1969–1974.

Gunter and Edwards (1969) suggest that high rainfall is necessary in Texas to dilute the estuaries for optimum white shrimp production, while lower than normal river discharge is necessary in Louisiana for optimum white shrimp production, since these estuaries were less saline than those in Texas.

Growth of postlarval and juvenile pink shrimp in Florida appears to decline as salinity increases from 10 to 28 ppt and may increase as temperature increases from 15° to 32° C (Higman, et al., n.d.). This apparent relationship between growth and salinity is in contrast to the observation that juvenile pink shrimp normally occupy a higher salinity area on nursery grounds than do brown or white shrimp (Gunter, et al., 1964).

Highest densities of royal red shrimp are found at 9° to 10° C and most occur within 8° to 12° C (Roe, 1969).

Migration and Spawning

Spawning of white shrimp has been associated with the sudden warming in the spring of the offshore waters of the northern Gulf (Lindner and Anderson, 1956).

Both white and pink shrimp apparently seek deeper water as water temperatures fall in the fall and winter and will reenter shallow water if temperature rise (Lindner and Anderson, 1956; Tabb, et al., 1962).

Bioeconomic Models

Grant and Griffin (in press) and Biomo, et al., (1978) have developed a bioeconomic simulation model of the brown shrimp fishery of Galveston Bay, Texas, and its associated offshore waters. The model is designed to assess the change in yield and revenue recruited to the fishery if various restrictions are imposed on either area of catch or fishery effort. Work is currently underway to adapt this model to the Dry Tortugas pink shrimp fishery (Griffin, personal communication, 1979).

4.2 Stock Unit

A stock is defined as a group of fish manageable as a unit. This definition differs from the biological concept of a stock as a more or less freely interbreeding population of a species.

The effects that strategies for increasing the yield for one of these species may have on other species of national interest as well as other multipurpose uses of the area involved must be considered (Section 3.6). Management and conservation of Gulf shrimp has been carried out mainly by the several Gulf States. Management policies employed by these States differ (Section 3.3.1); these differences largely reflect differences in the history of exploitation (Section 3.2).

Given this apparent genetic continuity, the need for a multipurpose approach to management, and the partial lack of data necessary to

evaluate potential benefits derived by modifying current management practices, the GMFMC, realizing that management must consider other mutipurpose uses for national resources and may have to consider area differences in harvesting strategies, has adopted the FMP group of species as the management unit for the Gulf shrimp fishery.

4.3 Catch-Effort Data

The National Marine Fisheries Service has collected data on shrimp landed by commercial fishermen. Griffin (1978) has prepared estimates for the 1963–1975 period on unit fishery effort for brown, white, and pink shrimp. (See Appendix B for review of his technique.)

Published accounts of recreational and bait-shrimp catch and effort are comparatively sparce. The few published estimates of discarded catch are summarized in Section 4.7.

4.4 Survey and Sampling Data

Christmas and Etzold (1977) reviewed the major survey and sampling programs which exist in order to monitor the shrimp resource and predict yields.

Texas: Texas has sampled its key bay areas from March to May for brown shrimp and from June to September for white shrimp. In addition Texas Parks and Wildlife Department also monitors the size, distribution, and abundance of shrimp in the open Gulf.

Louisiana: Louisiana has an ongoing shrimp monitoring program in the estuaries March through October. The program provides the data needed to set the opening date and predict the success of the brown shrimp season.

Mississippi: There is a year-round monitoring of all Mississippi's marine resources. In addition, an intensive sampling of juvenile shrimp occurs from mid-April through summer to provide growth and size data for opening of the inshore brown shrimp season.

Alabama: An ongoing shrimp monitoring program extends from April through September of each year to provide background data as well as to set seasons.

Florida: Florida surveys for age information, and for the life cycle and population dynamics of rock and pink shrimp in offshore waters.

NMFS: NMFS surveys provide the number, weight, and species composition.

4.5 Habitat

Brown, white, and pink shrimp use a variety of habitats as they grow from planktonic larvae to spawning adults. In part, this migration tends to separate the various life stages so that they are not in direct competition for the same resources. As planktonic larvae the shrimp feed on phytoplankton and zooplankton and exist mainly in the open Gulf. As postlarvae they enter the estuaries and adopt a benthic existence at the marsh-water, mangrove-water interface, or with grassbeds. The estuarine phase is considered a critical stage because local fluctuations in temperature and salinity have a dramatic affect on both the acres of marsh available for growth and the actual growth rate of the shrimp. As the shrimp grow, they move away from the marsh-water or mangrove-water interface into deeper, more open waters. At some point they begin an offshore migration to the Gulf. The major species tend to be partly separated in the Gulf. Brown and white shrimp predominate on the mud and sandy mud bottoms of the northwestern and northern Gulf; pink shrimp predominate on the coral sand bottoms of the southeastern Gulf. Adult brown shrimp tend to migrate to deeper waters (30 to 50 fathoms) than adult white shrimp (10 to 20 fathoms).

The weakest link in the life cycle chain is the estuarine phase of growth. Man's alteration of the fragile environment has removed much of the area that would be considered suitable shrimp habitat. Some of these alterations are easily assessed. These include:

- Impoundments that prevent influx of shrimp.
- Bulkheading that removes the critical marsh-water or mangrove-water interface.
- Alterations in freshwater discharge that create an unfavorable salinity regime.

The immediate effects of other alterations are not as easily assessed. These include:

- Stimulation of saltwater intrusion.
- The continuing encroachment of polluted waters on the estuarine waters.

Despite any uncertainty about the effects of these alterations, we do have indications of the kind of environment necessary for shrimp survival. Turner (1977) observed that the yield of shrimp in Louisiana's estuaries is directly related to the acreage of marsh, while that from the northeastern Gulf of Mexico is directly related to the acreage of marsh and submerged grassbeds. He found no relationship between yields and estuarine water surface, average water depth, or volume. His findings concur with the observations of Barrett and Gillespie (1973) that annual brown shrimp production in Louisiana is correlated with the acreage of marsh with waters above 10 ppt salinity, but not with acres of estuarine water above 10 ppt salinity. These findings suggest that the brown, white, and pink shrimp yields in the U.S. Gulf of Mexico depend on the survival of the estuarine marshes, mangrove areas, and grassbeds in their natural state. These areas not only provide postlarval, juvenile, and subadult shrimp with food and protection from predation, but they help to maintain an essential gradient between fresh and salt water.

4.5.1 Physical Description of the Habitats

The following parameters are used in characterizing shrimp habitats around the Gulf Coast:

1. Bottom types
   a. Offshore
   b. Inshore
2. Surface water discharge into estuaries
3. Estuarine salinities
4. Areal extent of estuaries
5. Estuarine availability (access from open Gulf)
6. Water quality (with emphasis on low salinity)

All of these factors vary over space and time.

Habitats can change from one type to another, and the changes can be either culturally induced (i.e., filling or dredging of wetlands) or naturally induced (i.e., subsidence of wetlands resulting in its conversion to open water). These changes are critically important to the Gulf's estuarine-dependent species. Documented evidence of the effect of permanent changes in essential habitats is severly limited, except for the change in wetland area.

An important component in the habitat of the estuarine dependent shrimp is the wetland zone along the Gulf coast. Salinity regimes critically needed for shrimp occur in these areas, and their primary production (vegetation) is the basis for the shrimp's detritus food web.

The wetlands along the Gulf coast have formed during approximately the past 5,000 years, when alluvial sediment supplied to the coast exceeded that removed through erosion and subsidence. The general physiography of the Gulf coast has favored extensive wetland formation. Some 60 percent of the coastal wetland area of the conterminous United States occurs along the Gulf coast. Tidal marsh, mangroves, and submerged aquatics that comprise this area amount to some 6.2 million acres. An additional 8.4 million acres are classified as unvegetated estuarine open water (Crance, 1971; Chabreck, 1972; McNulty,

Lindall, and Sykes, 1972; Christmas, 1973; Diener, 1975).

Wetlands are not evenly distributed along the Gulf coast. Some 73 percent of the emergent wetlands along the Gulf are found in Louisiana as the result of an abundant sediment supply transported by the Mississippi River. Some 395,00 acres of mangrove are found almost exclusively along the Florida coast. While substrate and currents (to carry germinated seeds) are generally favorable along the entire Gulf coast, mangrove distribution is limited to areas where hard freezes do not occur. Submerged vegetation is found along most of the Gulf coast but is particularly abundant and diverse along the shores of central and southern Florida. Information on submerged vegetation is generally lacking for other states.

The relative abundance and type of submerged vegetation depends mainly on bottom type, turbidity, salinity, water temperature, bottom slope, and tidal range (McNulty, Lindall, and Sykes, 1972). Along the Gulf coast of southern Florida nearly 50 percent of the estuarine bottoms are covered by submerged vegetation. Cover density generally decreases as one moves northward, with bays along the panhandle having only five percent of their bottoms vegetated. Reports for isolated study sites indicate that the five percent figure would hold for the remainder of the Gulf coast, except for portions of Louisiana where the percentage would be less, and the lower Texas coast where abundance is greater. Lindall and Saloman (1977) report 796,806 acres of submerged vegetation in estuaries along the Gulf, of which 63 percent are found in Florida and 31 percent are found in the Laguna Madre and Copano-Aransas Bays in Texas.

4.5.1 Bottom Types

4.5.1.1.1 Offshore Bottom Types

There are three general offshore bottom type regions extending to the 200 m isobath in the Gulf of Mexico. One occurs from the Texas-Mexico border to just west of the Texas-Louisiana border. Here the offshore zone consists mainly of sand and finer grain sediments. Occasional pockets of sand and shell are found from the 11 to 109 fms (20 m to 200 m) isobath. The second zone extends eastward to a point approximately even with Pascagoula Bay, Mississippi, and is mainly a complex of fine grain sediments with occasional surface deposits of sand and shell. The dominance of muddy bottoms in this zone is attributed to the deposition by the Mississippi River. The third region encompasses the remaining area offshore Alabama and Florida, which is almost exclusively comprised of sand, shell, and coral. Coral becomes more prevalent along the central and southern Florida coast.

The first two zones are primarily associated with brown and white shrimp, while the third zone is primarily associated with pink shrimp.

4.5.1.1.2 Estuarine Bottom Types

Many of the estuaries found along the Gulf of Mexico represent drowned river valleys, which have subsequently undergone some degree of fill. Generally those estuaries that still have considerable freshwater flow coming in at the head contain bottom sediments that reflect the stream load. Those with little or no stream flow are generally dominated by marine sediments and are usually coarser. Estuaries formed by deltaic progradation and subsequent deterioration are dominated by muddy bottoms.

4.5.1.2 Surface Water Discharge

Freshwater flow into the estuaries of the northern Gulf of Mexico is variable in space and time (Fig. 4.5–1) largely because of differences in drainage basin area, lithology, climate, and land use.

Two aspects of surface water flow are considered in terms of their effect on shrimp habitat: 1) the volume entering the estuaries and 2) the seasonal variability of the hydrography. Four regions of surface water flow are identified:

1. Lower Texas coast
2. Upper Texas coast through the Panhandle of Florida, except for the Deltaic plain of Louisiana
3. Deltaic plain of Lousiana
4. Central and lower Florida coast

Lower Texas Coast

Rivers of the lower Texas coast have relatively low discharges, with peaks occurring in the spring and fall. Low discharge is due to the semi-arid conditions and relatively small drainage areas of the rivers. More to the south, the fall peak is first noticeable on the hydrographs of streams entering the Matagorda Bay system. In the San Antonio Bay system, the fall peak is very pronounced, and, from Aransas Bay through Laguna Madre, the fall peak exceeds the spring peak. In Laguna Madre, however, the total volume of discharge is extremely low, 9 to 200 cfs (1950–1977).

Occasional heavy rains (often associated with tropical disturbances) can have a substantial short term effect on the estuaries and may affect shrimp yields if the resulting flood waters enter the estuaries during critical growth periods of shrimp.

BILLING CODE 3510-22-M

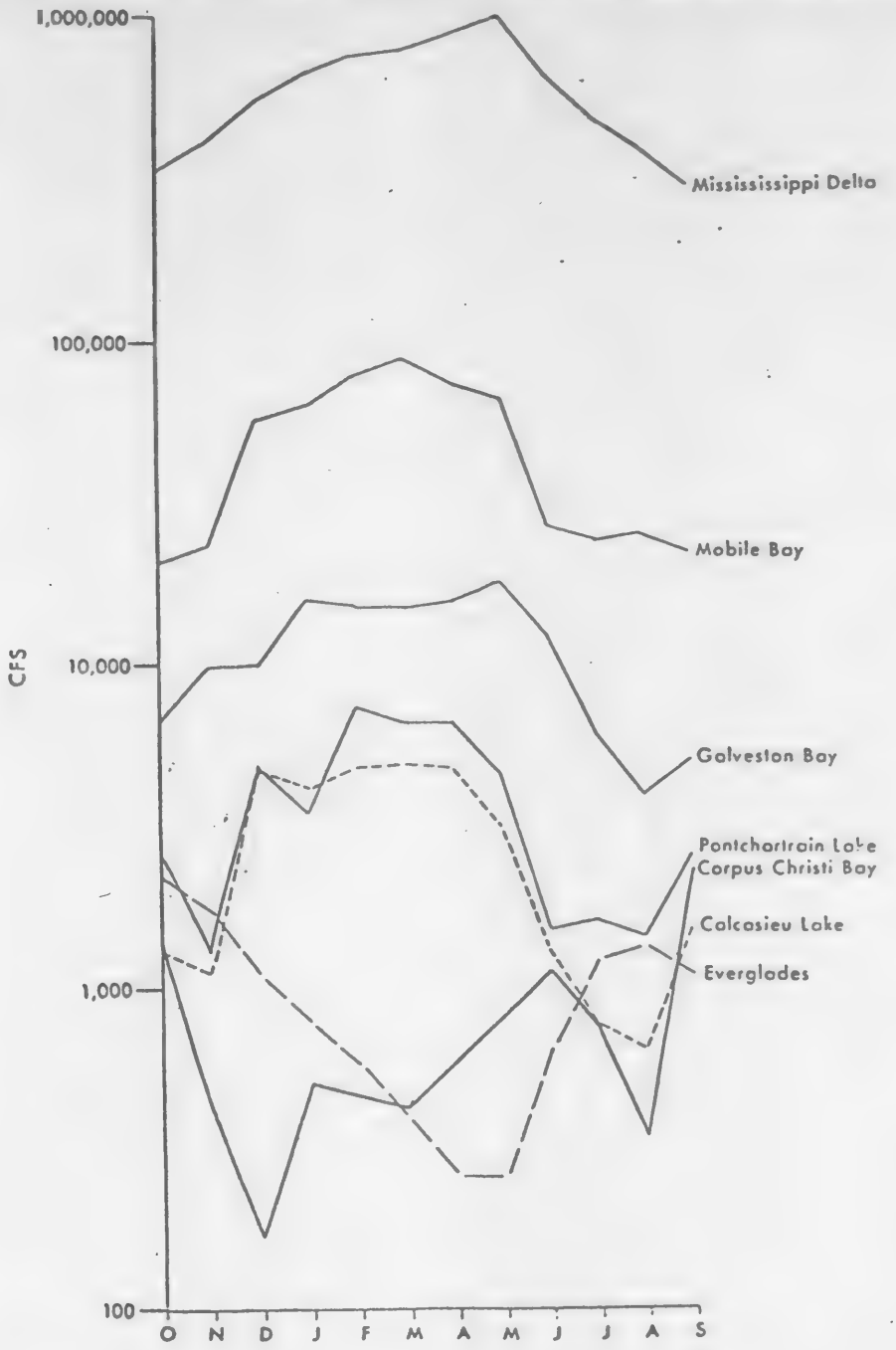


Figure 4.5-1 Ten Year Mean Freshwater Discharge Into Selected Gulf Coast Estuaries (U.S. ACOE and USGS Water Resource Data).

BILLING CODE 3510-22-C

Upper Texas Coast Through the Panhandle of Florida, Except for the Deltaic Plain of Louisiana

Most of the rivers from the panhandle of Florida west to Galveston Bay, Texas, have a peak discharge in early spring, followed by low discharge during the summer and early fall months. Mean monthly precipitation is generally similar throughout the year; however, a high degree of variability exists from year to year. The differences in seasonal distributions of precipitation and discharge are primarily attributed to the seasonal differences in evapotranspiration rates and to the spring release of precipitation stored in winter as soil moisture and snow.

Deltaic Plain of Louisiana

The Mississippi and the Atchafalaya are by far the largest suppliers of fresh water to the Gulf of Mexico (Fig. 4.5–1). Peak discharge usually occurs in April through May; low flow typically occurs in September through October. During periods of flood, fresh water, carried by the Gulf into the mouths of neighboring estuaries, results in lower salinities.

Though extremely variable in magnitude, the monthly flow of the Mississippi River is less variable in relation to average flow than any other gauged rivers entering the Gulf. Its variance in flow, however, has a noticeable effect on the yield of brown shrimp in the Gulf (Section 4.1) and on white shrimp in Louisiana (White and Boudreaux, 1977).

Central and Lower Florida Coast

Stream flow entering the Everglades is lower than most areas of the Gulf, largely because of the small contributing drainage area. The additional input of groundwater is recognized, but its significance cannot be determined.

The seasonal flood cycle is asymmetrical. The peak rises rapidly in early summer, continues into the fall, and then drops slowly to a low stage during the months of April and May (Fig. 4.5–1). The summer maximum differs from most other Gulf rivers in that the latter are typically at low stage during the summer. This difference reflects the greater influence of tropical climate in the Everglades where summer showers are typically intense and result in higher stream flow despite evapotranspiration rates. From Charlotte Harbor north to Suwannee Sound, the seasonal hydrograph is in transition between the summer fall peak of the south and the late winter-spring peak common along the northern Gulf coast. South of Suwannee Sound the total volume of stream flow is small.

4.5.1.3 Estuarine Salinity

Throughout the Gulf of Mexico estuarine salinity is highly variable in both time and space. Salinity ranges from 0 ppt to a high of 113.9 ppt recorded in Laguna Madre (Hedgepeth, 1953, in Diener, 1975).

Because of severe data inadequacies, it is rather difficult to make a Gulf-wide comparison of salinity in the various estuaries. There are few estuaries in which salinity is continually monitored. In those which are monitored by public agencies, station locations are such (for example, along major dredged waterways) that data often do not reflect general conditions of the estuary.

This section is limited to presentation of averages and extremes; these values, however, are generally based on limited data and present a superficial picture. As a result, many of the estuaries appear quite similar with respect to salinity. The ensuing description of salinity in various estuaries is based largely on secondary reference material, and all values are for surface salinities unless otherwise noted.

Laguna Madre: The only estuary in the Gulf which is almost continually hypersaline had average annual isohalines ranging from 35 to 55 ppt (1963–1966), with lower salinities occurring at tidal passes rather than inland (Diener, 1975).

Corpus Christi Bay: The Nueces River helps to maintain salinities lower than those of average seawater. Most of Corpus Christi Bay averaged between 30 to 35 ppt (1963–1966). Hypersaline conditions can be expected during low discharge periods.

Copano-Aransas Bays: Salinity ranged from 6 ppt in Copano Bay and 12 ppt Aransas Bay near the Gulf Intracoastal Waterway (GIWW) during flood periods, to 32 ppt in Copano Bay and 35 ppt in Aransas Bay during low discharge periods of the Mission River (1965–1967, McGowen, et al., 1976).

San Antonio Bay: The Guadalupe River strongly influences the salinity in San Antonio Bay. During periods of flood, the entire bay above the Gulf Intercoastal Waterway may be fresh; during low flow, slightly hypersaline conditions occur in some parts of the bay (1965–1967, McGowen, et al., 1976). Average salinities range from 6 ppt at the head to 20 to 25 ppt at the GIWW and decrease slightly on the lee side of Matagorda Island.

Matagorda Bay Complex: The Lavaca River and several streams affect salinity. Salinities range from 0 ppt at the head of Lavaca and Tres Palacios Bays and 20 ppt near Port O'Connor during flood periods, to 30 ppt at the head of the bays and slightly hypersaline conditions near Port O'Connor during low discharge (1965–1967, McGowen, et al., 1976). East Matagorda Bay is separated from Matagorda Bay proper by the Colorado River Delta. Several streams flow into East Matagorda Bay, and its opening to the Gulf consists of a single narrow cut. Salinities here are generally lower, averaging 10 to 15 ppt and ranging from a reported low of 8 ppt to a high of 24 ppt at Brown Cedar Cut (1965–1967).

Galveston Bay Complex: Considerable surface flow enters via the Trinity and San Jacinto Rivers and several small streams and bayous. These are the westernmost estuaries influenced by a humid climate, and hypersaline conditions are rare. Highest salinities are recorded in West Bay, averaging 25 to 30 ppt (1965–1967, Fisher, et al., 1972). Galveston and Trinity Bays average from 10 to 15 ppt near the head to 20 to 25 ppt in the lower portions. During high discharge, surface salinity ranges from 2 ppt to 14 ppt, and during low discharge periods the range is from 20 to 32 ppt (Fisher, et al., 1972).

Circulation between East Bay and Galveston Bay is rather poor (Gooselink, in press) perhaps because of numerous oyster reefs, and salinities are somewhat higher. The reopening of Rollover Fish Pass in 1955 improved circulation in the eastern half of East Bay.

Sabine Lake: Dredging of the Sabine-Neches Ship Channel and the construction of the Toledo Bend Reservoir are classic examples of how man has altered the natural salinity regime of Gulf estuaries. The dam stores winter surplus water, which is released in mid-May for hydroelectric generator demands (White and Perret, 1973). The mid-May release corresponds to the peak period of brown shrimp estuarine production. Alteration in this discharge pattern means the loss of the lake as a shrimp habitat (White and Perrett, 1973).

The natural opening of Sabine Lake to the Gulf was narrow and approximately 4 m deep (Gosselink, in press). This narrowness, combined with the large discharge into the estuary, probably resulted in low salinities throughout the area. The Sabine-Neches Ship Channel 46 ft. (14 m in depth) has resulted in unusual hydrographic changes. Spoil from the channel is continuous until the mouth of the Neches River, at which point an increase in lake salinity is noted. The ship channel acts as a corridor facilitating saltwater intrusion during low discharge periods and allows for more rapid runoff of high discharge.

Combined effects of the natural physiography and of these perturbations

have resulted in relatively low and monotonous annual salinity regimes. Salinities at the estuary's head range from 2 to 10 ppt (wet and dry years) and from 16 to 20 ppt (wet and dry years) at the south end of Sabine Lake (Fisher, et al., 1973).

Calcasieu Lake: This estuary is similar to Sabine Lake in its size, its orientation, and in that its constricted opening to the Gulf has been dredged. Salinity in the ship channel has increased since its construction (Gosselink, in press). Historic changes in oyster distribution and in marsh acreage and vegetation indicate that salinity has increased in the lake. Means and extremes are not known for the lake, but it seems that salinity here is somewhat higher than in Sabine Lake (Barrett, 1971).

Atchafalaya-Vermilion Bays Complex: Salinities are generally low due to the Atchafalaya River as well as to the other lesser sources of fresh water. A significant decrease in salinity has occurred in the Vermilion Bay area since 1950, for the expected continued growth of the Atchafalaya Delta will result in continued high turbidity levels and lower salinities. If the Delta grows out to the present coastline it may act as a barrier decreasing water exchange with the Gulf. The immediate estuarine area will probably deteriorate in terms of shrimp habitat over the foreseeable future. Over the long term, if the normal sequence of deltaic processes is not inhibited, the result will be a significant increase in estuarine habitat area (Gosselink, in press).

Terrebonne and Barataria Estuaries: Since artificial levies block the normal flow of the Mississippi River, these estuaries are no longer greatly influenced by freshwater runoff. During flood periods, Mississippi waters can enter into the mouths of these estuaries via the Gulf of Mexico and create a reversal in the salinity gradient (Barrett, 1971). While salinity data is extremely sparse, the extensive salt and brackish marshes indicate favorable conditions for shrimp habitat.

Mississippi Delta: The Delta marshes are generally too fresh to be significant shrimp habitats. Surface salinities are usually near zero ppt; however, a well-developed salt wedge moves upriver at low stage.

Pontchartrain-Breton Sound: Marshes in Breton Sound have salinities similar to those of the lower portions of the Barataria and Terrebonne estuaries (20 to 25 ppt, 1967–1968, Barrett, 1971).

Mississippi Sound Complex: Salinities in Mississippi Sound, despite its numerous wide passes, are considerably less than those of the Gulf. Freshwater discharge is considerable both directly (via the Pascagoula system and weirs entering into St. Louis and Biloxi Bays) and indirectly (via Mobile Bay to the east and the Pearl River and Pontchartrain-Borgne system to the west). At the western end, surface salinity ranged from 6 to 20 ppt, while at the east end it ranged from 14 to 30 ppt (1962–1964, 1966–1969, Christmas, 1973). The east-west gradient reflects differences in surface water inputs.

In the landward estuaries, such as Biloxi and St. Louis Bays, surface salinities range from less than eight ppt to 20 ppt. A fairly strong salinity gradient is present from the mouths of the estuaries seaward to the offshore barrier islands. This gradient is most evident from Biloxi Bay to Dog Keys Pass where surface salinities differ by about 12 ppt, with a range of 10 to 20 ppt over the 131 m distance.

Mobile Bay: Mobile Bay is another example of a shallow-water estuary modified by a deep-water channel that allows for saltwater intrusion. Mobile Bay receives more freshwater flow than any other U.S. Gulf estuary except for the Mississippi River and its tributary, the Atchafalaya. Consequently, salinity has a strong inverse relationship to stream flow.

Florida Estuaries: In the panhandle area and south to Suwannee Sound, salinity patterns are similar to those of the estuaries to the west. Salinities are highly variable and are related to stream flow, which is substantial for these areas. Choctawhatchee Bay is a glaring exception because of a well-defined persistent salt wedge (McNulty, et al., 1972).

Despite the lack of major freshwater surface flow, the coastline south of Waccassa Bay and north of Tampa Bay has salinities similar to those of the large-discharge panhandle estuaries. These lower-than-normal Gulf salinities have been a factor in the presence of offshore oyster reefs and submerged aquatics, suggesting the strong possibility of springs emerging in the offshore zone (McNulty, et al., 1972).

Relatively high salinities from Tampa Bay south through Florida Bay are due to the absence of major stream flow and high evapotranspiration rates. The frequency and degree of hypersalinity generally increases in a southerly direction, except for the Charlotte Harbor area where stream flow is normally sufficient to mitigate hypersalinity. Hypersalinity, a normal and frequent occurrence in Florida Bay, is brought about by natural drought periods and is intensified by man's diversion of normal freshwater flow (McNulty, et al., 1972). Higman (n.d.) discusses the possible inverse relationship between growth rate of postlarval and juvenile pink shrimp and salinity in Florida Bay estuaries.

4.5.1.4 Estuarine Access

The area becomes closed as a nursery ground if wetlands are impounded. Indirect effects may be considerable and may cause changes in water flow patterns. Control gates can close off nursery grounds landward of the structures.

Weirs constructed along the Sabine Navigation Channel and the Gulf Intracoastal Waterway in the Keith Lake area of southeast Texas to protect the neighboring marshes from saltwater instrusion were removed in 1977 reopening the Keith Lake area as a shrimp nursery ground (R. Fish, personal communication).

4.5.1.5 Non-Salinity Water Quality

The effects of pollutants on Gulf shrimp is still relatively unknown. Pollutants can reduce the available estuarine habitat area and result in high concentrations of substances harmful for human consumption.

4.5.1.6 Currents

The most important process in producing currents in the Gulf of Mexico is the stress of the wind upon the water surface. While the loop current in the eastern Gulf has been documented for some time, a major current in the western Gulf has only recently been firmly established (Sturges and Blaha, 1976). The loop current may serve as an eastern boundary to the Mexican current (Sturges and Blaha, 1976), especially during summer months.

Tidal currents are of particular importance in the nearshore area and affect movement into and out of estuaries. Despite the small tidal range throughout the Gulf, tidal current velocities are relatively high. In the estuaries high velocity is due to constricted outlets that characterize many of the lagoons and bays. In the nearshore area, water level changes occur over a shallow Continental Shelf. Wind can have a pronounced effect on the overall water level change. Two of the most dramatic examples are cold fronts that push water out of the northern Gulf estuaries and tropical disturbances that raise water levels in these same estuaries. Shrimp migration, from these estuarine areas is associated in part with the relative magnitude of the tidal exchange (Section 4.1).

4.5.2 Habitat Concerns

See introduction to Section 4.5, Habitat, and Section 4.8, Estimates of Future Stock Conditions.

4.6 Quality of Data

Despite the importance of the Gulf shrimp fishery, there are some significant data deficiencies which limit the selection of mangement measures. Some of these deficiencies include:

- Lack of a clear understanding of natural mortality rates, of temperature and salinity effects on growth rates, and of migration patterns.
- Lack of data on utilization of the shrimp resouces.
- Lack of cost-earnings and catch-effort data.

4.7 Current Status of the Stocks

4.7.1 Maximum Sustainable Yield

4.7.1.1 Explanation and Specification of MSY

The biological characteristics which affect sustainable yields for penaeid shrimp are unusual. They are an annual crop. Very few individuals live a year and the majority harvested are less than six months old. There is no demonstrable stock-recruitment relation and recruitment overfishing, given present technology, is essentially impossible. That is, it is not economically or technically feasible to take so many shrimp that there are too few survivors to provide an adequate supply for the following year. Because of these characteristics, fishing mortality and yield in one year do not affect yield in the following year. The maximum yield in number for a given year is essentially all the shrimp available to harvest, using current technology.

Growth overfishing is caused by taking the available recruits at too small a size. If growth overfishing is occurring, allowing additional time for growth will result in a greater total yield in weight, although the total number of individuals will be less. The rapid growth rate of penaeid shrimp makes them resistant to growth overfishing until high levels of effort are reached. Effort in the fishery has been increasing rapidly, and it is probable that the total yield of penaeid shrimp could be increased if the average size taken were larger. However, the poor quality and small amount of available data makes it difficult to precisely estimate the magnitude of any increase (see Section 4.1).

The abundance (number of recruits) and therefore yield and catch per unit effort, vary greatly from year to year depending on the temperature and salinity in the estuarine nursery areas. This is evident when regression coefficients for the different models are compared. For example, linear regressions of catch on effort showed that effort alone explained only 38 percent of the variation in catch of Louisiana white shrimp and 57 percent of the variation in Gulf brown shrimp catch. Multiple regressions including environmental parameters explained 89 percent and 88 percent respectively. For brown shrimp, the environmental model predicts that at a fishing effort of 100,000 units (essentially the record until 1976), annual catch would vary from 57 to 88 million pounds provided temperature and salinity ranged within 1963–1975 levels. If environmental conditions were more favorable, a greater yield would be expected. Given environmental conditions slightly better than previously observed and high levels of effort, the maximum probable catch is estimated at 116.4 million pounds tails, 37.6 percent greater than the point estimate of MSY from a Schaefer surplus production model.

Surplus production models utilize trends in catch and fishing effort over a series of years. They were designed for, and are usually applied to, species with multiple year classes, (i.e., individual animals live longer than one year). They do not consider fluctuations in recruitment controlled by environment, but assume that environmental effects are constant. The predictive ability of these models, particularly in the range of fishing effort which might produce overfishing, is at its best for long-lived species and/or those which are not subject to large, environmentally produced fluctuations in recruitment. Because penaeid shrimp meet neither of these criteria, application of surplus production models must be made with caution and with an understanding of what is being predicted by the model. Estimates of MSY produced should be considered as long-term averages which are greatly affected by environmental conditions. They should not be considered a maximum allowable catch for a given year.

The Schaefer version of the surplus production model was chosen to estimate MSY in all three species because: sufficient data were available; it fit the date as well as other models which gave similar estimates of MSY, and was mathematically easier to use. The estimate was calculated using only reported catch and effort from the commercial fishery. Estimates of the recreational catch, bait catch, and discarded undersized shrimp are added.

	Schaefer commercial [1]	[illegible]	[illegible]	[illegible]	Total
Brown shrimp	85	8	2	5	[illegible]
White shrimp	38	[illegible]	[illegible]	[illegible]	[illegible]
Pink shrimp	14	.....	1	.....	15

[1] All weights are in millions of pounds, tail weight for a total MSY of 165 million pounds of tails annually for the three species.

For royal red shrimp, MSY was estimated as 392,000 lbs. of tails using a Schaefer model.

For rock shrimp, MSY was estimated as 1.1 million pounds of tails using a Schaefer model. This estimate is a very poor one because most landings are incidental catch, making effort estimates unreliable.

For seabob shrimp, no accurate MSY could be calculated due to lack of effort data. Seabobs are treated as an incidental catch, to the white shrimp fishery where they account for an average of 4.3 percent of the total catch or 1.4 million pounds (tails) for the years 1959–1975. This must serve as the best available MSY. The catch of seabobs is almost entirely within the Territorial Sea (Sec. 4.1).

For the three penaeid species, surplus production models indicate only a long term average yield, and not an allowable maximum. The catch in any given year can only be estimated using environmental factors and expected effort for that particular year.

A reasonable estimate of the maximum probable catch of white and pink shrimp can be estimated by applying the percentage by which the maximum probable catch of brown shrimp exceeds the Schaefer MSY estimate to all species. Estimates of bait catch, recreational catch and discards are then added to give a total maximum probable catch (see Sec. 4.7.1.2). These estimated are:

[In millions of pounds]

	Schaefer commercial catch	Maximum commercial yield considering environmental factors (137.6 pct)	Recreational	Bait	Discard	Total
Brown shrimp	85	117	8	2	5	132
White shrimp	38	52	8	1	3	64
Pink shrimp	14	19	.....	1	.....	20
Total	137	188	16	4	8	216

4.7.1.2 Technical Description of MSY Calculations

Yield Models Incorporating Environmental Driving Forces

To achieve reasonable accuracy, the calculation of specific yields for penaeid shrimp must be made for specific points in time and must include environmental driving forces, since yield is dependent on those forces and not on abundance in previous years. Such models are much more appropriate and useful for penaeid shrimps because of the overriding impact of the environment on yield.

The environmental models presented below do not estimate MSY in the classical sense, rather they provide a yield estimate for any year under given conditions. They fit empirical relationships to observed data but are not directly tied to biological parameters of the species such as growth rate or mortality rates. The estimates from these models become invalid if extreme and unrealistic values are used for fishing effort and/or environmental parameters. At average levels of river discharge and effort, these models produce yield estimates which approximate MSY estimates from surplus production models.

Griffin and Beattie (1978) attempted to do this using freshwater discharge from the Mississippi River as a proxy for estuarine salinity conditions. Their formula, a modified Spillman production equation (Heady and Dillon, 1961) estimates yield for that portion of Gulf shrimp resources of all species caught by vessels (i.e., five gross tons or larger). It predicts maximum yield will be attained only at infinite fishing pressure, although the rate of increase in yield decreases rapidly with increasing effort.

To estimate average yield, equivalent to MSY, Mississippi River discharge was used as an index of environmental driving forces, and the predictive equation derived is

$$Y = 6593D - {}^{0.60134}(1 - 0.995701^{E}) \quad \text{Eq. 4.7–1}$$

where Y is yield in million pounds of tails, D is Mississippi River discharge in thousand cubic feet per second, and E is fishing effort in thousand units. For a year with an average river discharge pattern, their equation predicts an average yield for Gulf shrimp vessels of 128.7 million pounds of tails. Within rounding error, 90 percent of this catch would be achieved at an expenditure of 314,300 effort units. The current range is 100,000 to 300,000 units.

For the purposes of this plan, it was necessary to consider each species individually. For white shrimp, the data was available only for Louisiana (Fig. 4.7–1).

The association of Louisiana's reported commercial catch of white shrimp (on a year-class basis) to unit fishing effort and Mississippi River discharge was investigated. It was found that the log of average river discharge for the May through August period (LMJJA) could be used as a forecaster for the success of the coming year's harvest (Y) if an estimate of commercial fishing effort (E) could be made (Figure 4.7–4),

$$Y = 127.8 + .6411E - 49.4LMJJA(R^2 = .84) \quad \text{Eq. 4.7–2}$$

where Y is in million pounds tails of white shrimp, LMJJA is the log of river discharge in 1,000 cfs and E is in 1,000 units. This time period encompasses the early phase of estuarine growth. It was also noted that the relationship in Eq. 2 was improved (increased R^2) if the time period over which river discharge was averaged was increased from the May through August period to May through December.

$$Y = 129.1 + .6411E - 51.48LMD(R^2 = .89) \quad \text{Eq. 4.7–3}$$

where LMD is the log of the average river discharge in 1,000 cfs for the May through December period. This longer time period essentially encompasses the first growing season for white shrimp.

These models could not be applied to the entire Gulf white shrimp catch because shrimp production from estuarine areas not connected to the Mississippi River are substantial and do not always correlate well with Louisiana production.

For pink shrimp no data was available to fit these types of models.

For brown shrimp in Louisiana, a correlation has been drawn between the annual success of the brown shrimp harvest and the temperature of both the estuarine water during mid-April and the acres of marsh above 10 ppt. (Barrett and Gillespie, 1973, 1975, 1976; Barrett and Ralph, 1977). In general, good production is expected if the spring is dry and warm, whereas poor production is expected for a wet, cold spring. A similar phenomenon has been observed in Texas (T. Leary, GMFMC, personal communication, 1978).

After the success of the Louisiana Department of Wildlife & Fisheries in predicting its brown shrimp harvest with these environmental variables, and given the fact that the successes of many of the major brown shrimp fishery areas in the Gulf are correlated with the Louisiana catch, "Barrett's" indicators were then tested for their ability to predict the annual Gulf brown shrimp catch. Results of the multiple regression equation generated are shown in Figure 4.7–2. The equation,

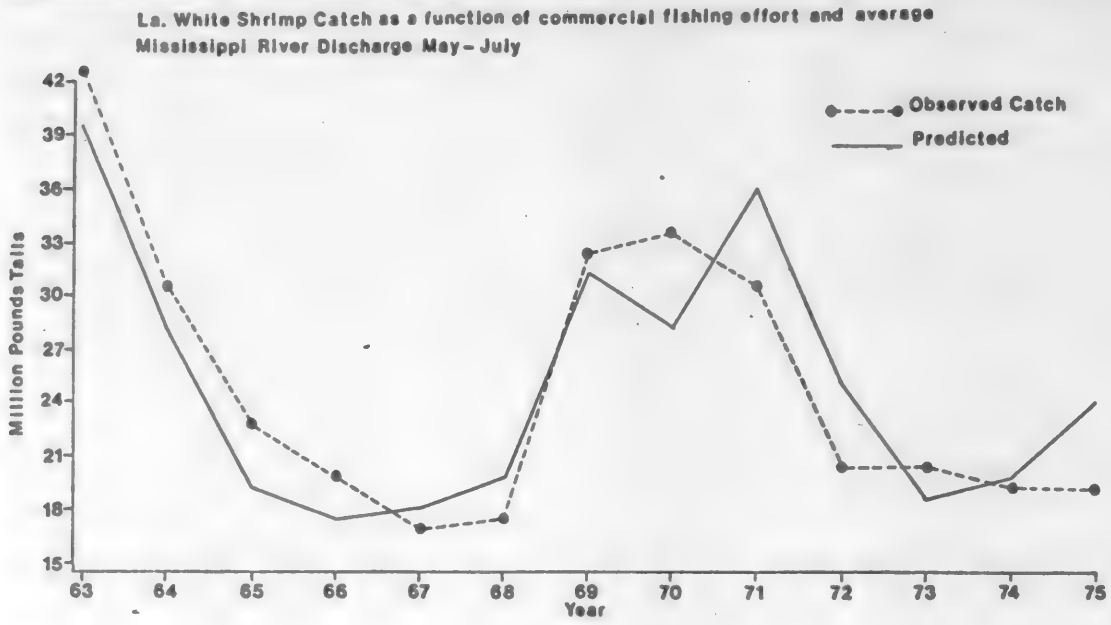
$$\text{Catch} = -51.73 + 3.664(\text{Temp}) - 0.01496(\text{River}) + 0.5061(\text{Effort}) \quad \text{Eq. 4.1–4}$$

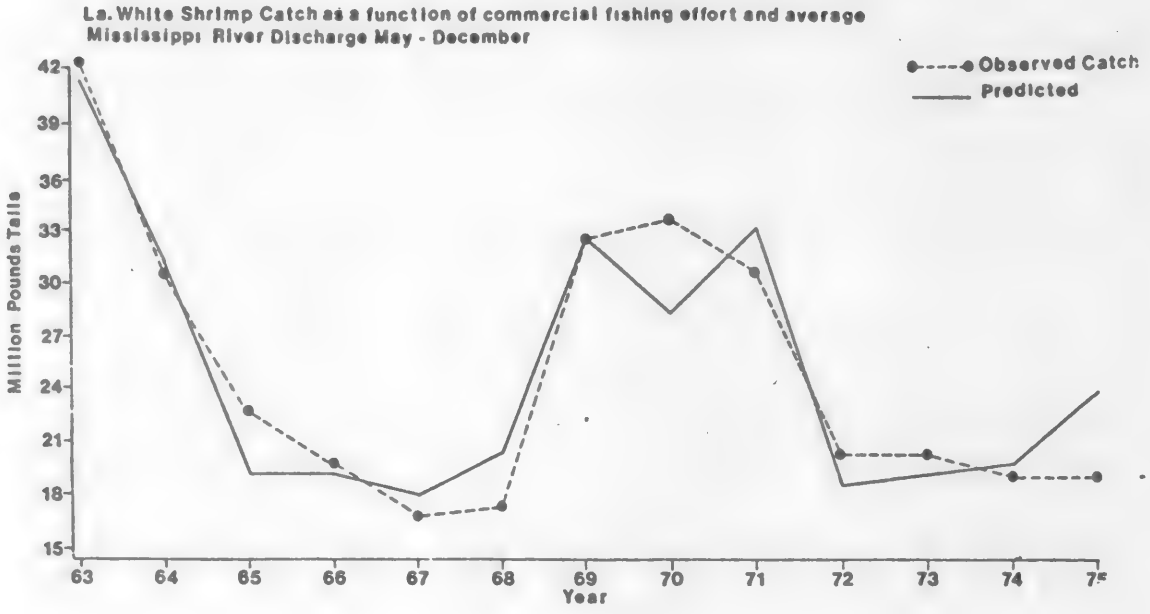
predicts 88 percent of the annual variance in catch, where "Catch" is annual brown shrimp catch in million pounds, "Temp" is average water temperature in degrees Centigrade at Grande Terre, Louisiana, April 16 to 22, "River" is Mississippi River discharge in 1,000 cfs March to May, and "Effort" is unit fishing effort in 1,000 units (Griffin, 1978).

In general, low freshwater discharge and high temperatures mean large yields (temperature is the most important factor). The estimated yield for the most favorable recorded combination of temperature (26.3° C in 1967), river discharge (480,000 in 1963) and effort (113,569 in 1972) is 94.9 million pounds. This compares with the best reported catch of 91.5 million pounds in 1967. To calculate a maximum probable yield, it is reasonable to assume slightly better environmental conditions and higher levels of effort. Using 27° C, 480,000 cfs and 150,000 effort units, the yield estimate is 116.4 million pounds of tails. This estimate is 37.6 percent greater than the estimate of MSY from the Schaefer surplus production model and more nearly resembles true conditions.

This model is an adequate predictor of reported annual Gulf brown shrimp harvest, although there is considerable room for refinement and improvement. When the necessary data becomes available, this type of model should be used for all penaeid shrimp.

BILLING CODE 3510-22-M





4.9-1 Louisiana white shrimp commercial reported catch as a function of commercial fishing effort and average Mississippi River discharge. (See Appendix E for derivation of equations.)

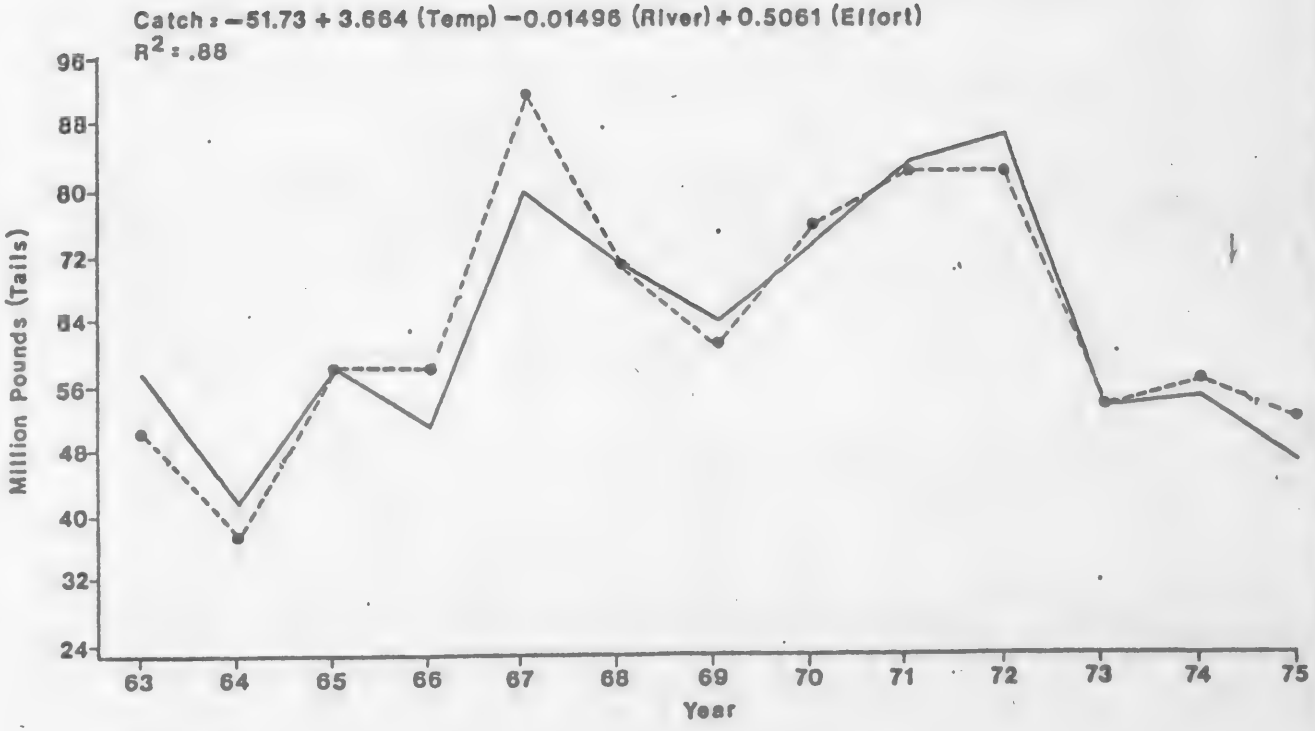


Figure 4.7-2. Predicting the annual US Gulf of Mexico harvest of brown shrimp by the commercial fleet. TEMP is the temperature at Grand Terre, Louisiana, April 16-22 in °C, RIVER is the average Mississippi River Discharge in 1000 cfs for March through May, and EFFORT is 1000 units of unit fishing effort. The solid line represents the solution to the predictive equation and the points represent the actual reported commercial harvest. (See Appendix D for derivation of equation.)

BILLING CODE 3510-22-C

As shown by the calculations above, surplus production models which do not incorporate environmental forces are inappropriate for these species. They are only used because of a lack of the required environmental data.

Surplus Production Models

Klima and Parrack (1978) used the Schaefer form of the Generalized Stock Production (GSP) model to predict a MSY for the shallow-water catch of Gulf shrimp (brown, white, pink, seabob, and rock shrimp). They used estimates of reported commercial catch and days fished for the period 1956–1975, excluding 1957, 1961, and 1962 as years of major hurricane activities and therefore not indicative of normal fishing activity. Their equation,

$$Y = E(.45528 - 9.3870396 \times 10^{-7}E) \quad \text{Eq. 4.7-4}$$

(where Y = yield in metric tons and E is effort in days fished) predicts an annual MSY for these shallow-water shrimp of 55 thousand metric tons (121 million pounds) of tails harvested by 225,000 days fished. They noted that annual catch has fluctuated around this maximum since 1970 and conclude that the shallow-water shrimp "have been fully exploited in recent years."

In developing this plan an attempt was made to find the most predictive model relating catch to fishing effort for each of the shrimp species harvested in the U.S. Gulf. Models used were the Spillman production equation (Dillion and Heady, 1966) (for brown, white, and pink shrimp) and the Generalized Stock Production model (GSP) (Pella and Tomlinson, 1969; Fox, 1975). Four levels of m were used in fitting the GSP model: m = 0.5, 1.5, 2.0, 3.0. The parameter m is a measure of how a stock reacts to increasing fishing effort and overfishing.

The available catch data include the reported commercial catch-effort data published in the Gulf Coast Shrimp Data (U.S. Department of Commerce, 1963–1975) as well as point estimates of recreational, bait, and discarded catch and (in some cases) effort. To test the fit of the models to available data, only the reported commercial catch and effort data were used, since these were the only data with reliable time-series, catch-effort estimates.

Brown, white, and pink shrimp commercial catch-effort data (U.S. Department of Commerce, 1963–1975; Griffin, 1978) are listed in Table 4.7–1. Yield curves were fitted to this reported commercial catch and are compared in Figure 4.7–3 and Table 4.7.2. Essentially, all the models suggest that brown, white, and pink shrimp are being harvested within their respective MSY ranges. With each species, the fit (compare the residual sum of squares) is generally better with the GSP models than with spillman equation, and within the GSP models the fit becomes better with increasing m.

Choosing one of these models over another because of the apparent fit of the data is questionable. The fit of the data points to any of the surplus production models is relatively poor because of fluctuations in abundance caused by environmental factors. Although the GSP model where m = 3 appears to give the best fit, this type of model is usually associated with species which are very susceptible to recruitment overfishing. Penaeid shrimp are very resistant to this type of overfishing.

There are other factors which may be affecting the fit of the data. Most of the points lie near the peak of the yield curve. This makes prediction of the effects of higher levels of effort unreliable. A fraction of the catch is unreported. If this fraction is increasing and is large, it would cause the reported catch effort data to fit the curve where m = 3 more closely. Environmentally induced fluctuations in abundance cause great scatter in the points. In the case of white shrimp the shape of the curve is greatly affected by one point, 1975. Removal of this point would result in a large change in the right half of the curve.

Table 4.7–1—*Reported commercial catch and effort data for brown, white, and pink shrimp for 1963–76 (data from Griffin 1978). Weight is tail weight.*

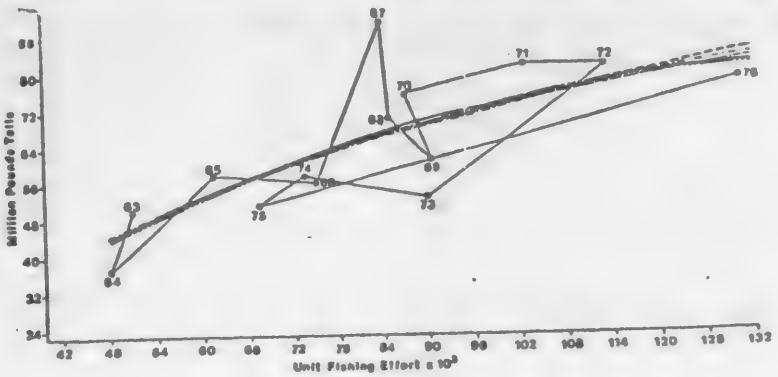
Year	Brown shrimp		
	Catch (1,000,000 lb)	Days fished (1,000 d)	Unit effort (1,000 units)
1963	[illegible]	[illegible]	51.3
1964	[illegible]	74.1	[illegible]
1965	57.0	102.4	61.6
1966	57.7	111.9	73.6
1967	91.5	116.6	[illegible]
1968	71.1	117.8	[illegible]
1969	61.5	114.6	[illegible]
1970	75.3	117.4	[illegible]
1971	81.1	[illegible]	102.6
1972	81.4	144.0	113.6
1973	[illegible]	115.3	[illegible]
1974	55.8	[illegible]	74.9
1975	[illegible]	86.6	[illegible]
1976	77.8	181.9	130.3

Year	White shrimp		
	Catch (1,000,000 lb)	Days fished (1,000 d)	Unit effort (1,000 units)
1963	[illegible]	[illegible]	55.7
1964	43.6	[illegible]	[illegible]
1965	33.2	74.5	51.2
1966	[illegible]	72.1	43.6
1967	24.2	61.6	[illegible]
1968	30.3	77.4	52.0
1969	44.5	115.1	78.4
1970	[illegible]	91.3	72.6
1971	42.0	88.7	[illegible]
1972	37.7	91.8	76.3
1973	34.0	115.6	[illegible]
1974	31.3	96.1	67.5
1975	27.6	121.8	[illegible]
1976	36.5	111[4	87.7

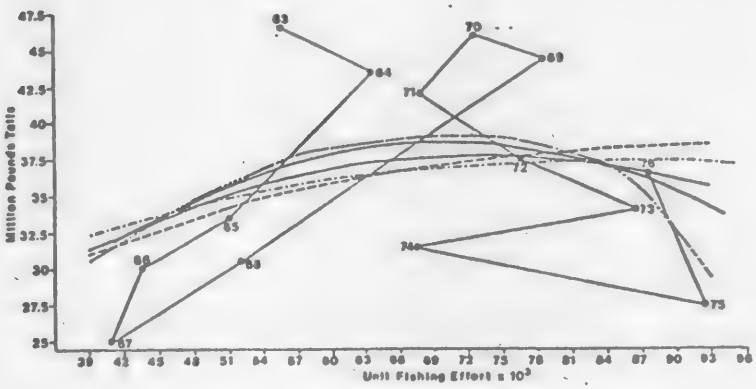
Year	Pink shrimp		
	Catch (1,000,000 lb)	Days fished (1,000 d)	Unit effort (1,000 units)
1963	12.4	21.9	15.3
1964	14.2	25.0	18.5
1965	14.6	23.3	17.4
1966	13.9	23.1	17.5
1967	10.2	21.7	16.7
1968	11.4	22.4	17.5
1969	11.1	21.5	17.8
1970	12.7	20.2	16.8
1971	10.3	17.8	15.1
1972	10.9	21.5	18.7
1973	14.5	25.4	22.4
1974	15.1	27.1	[illegible]
1975	14.6	31.3	[illegible]
1976	13.0	29.4	[illegible]

BILLING CODE 3510-22-M

BROWN



WHITE



PINK

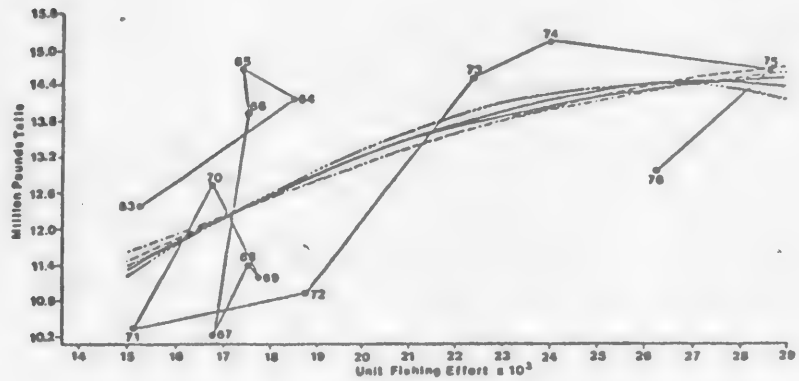


Fig. 4.7- 3. Comparison of the fit of various surplus yield modes to the reported commercial catch of brown, white, and pink shrimp in the US Gulf of Mexico. Equations and estimates of MSY and f opt are listed in Table 4.7-2. Spillman — — — — ; GSP, m = 0.5 — · — · — ·; GSP, m = 1.5 ····· ; GSP, m = 2.0 ———— ; GSP, m = 3.0 ——·····—;

BILLING CODE 3510-22-C

Table 4.7-2.—*Comparison of Point Estimates of MSY Generated by Fitting[1] Various Surplus Yield Models to the Reported Commercial Catch Data for Brown, White, and Pink Shrimp as Reported in Table 4.7-1*

Species and model	Equation predicted	Residual sum of squares	Predicted MSY (1,000,000 lbs tails)	Predicted f_{opt} (unit fishing effort—1,000 units)
Brown Shrimp:				
Spillman*	$Y = 113.5\ (1 - .9896^{E})$	1,315	113.5	.....
CSP **, m = 0.5	$Y = .5268\ E\ (.6513 + .001970\ E)^{-2}$	1,320	102.8	131
CSP **, m = 1.5	$Y = .5431\ E\ (1.448 - .002846\ E)^{2}$	1,296	85.8	170
CSP **, m = 2.0	$Y = 1.087\ E - .003491\ E^{2}$	1,283	84.8	156
CSP **, m = 3.0	$Y = .3\ E\ (12 - .059\ E)^{5}$	1,265	81.4	136
White Shrimp:				
Spillman	$Y = 39.92\ (1 - .9272^{E})$	862	39.5	.....
CSP, m = 0.5	$Y = .9626\ E\ (.7821 + .008144\ E)^{-2}$	573	37.8	56.6
CSP, m = 1.5	$Y = .7073\ E\ (1.299 - .006041\ E)^{2}$	497	36.0	71.7
CSP, m = 2.0	$Y = 1.102\ E - .007885\ E^{2}$	447	36.5	69.6
CSP, m = 3.0	$Y = .6039\ E\ (2.702 - .02604\ E)^{5}$	377	39.6	69.2
Pink Shrimp:				
Spillman	$Y = 16.23\ (1 - .9211^{E})$	25.7	16.2	.....
CSP, m = 0.5	$Y = .9102\ E\ (.8224 + .01782\ E)^{-2}$	25.7	15.5	46.1
CSP, m = 1.5	$Y = .8851\ E\ (1.115 - .01255\ E)^{2}$	25.3	.....	39.8
CSP, m = 2.0	$Y = 1.036\ E - .01866\ E^{2}$	25.1	14.4	27.8
CSP, m = 3.0	$Y = .3043\ E\ (9.794 - .2494\ E)^{5}$	25.0	14.4	26.2

[1] The NLIN procedure in Barr et al. (1976) was used to fit the data to the curvilinear models. All three iterative procedures provided in the NLIN program were used. Only the solution with the lowest residual sum of squares is presented in the "Equation Predicted" column for each species-model combination.

*$Y = M\ (1 - A^{E})$ where Y is yield in million pounds tails, M is the maximum yield, A is a constant, and E is thousand units of fishing effort.

**Equation 4.7-1 where catch in million pounds and effort is in 1000 units of effort.

***Corrected total sum of squares for brown shrimp data is 3138, for white shrimp data is 692, and for pink shrimp data is 39.3

The Schaefer model, which is equivalent to the GSP where m = 2, was chosen as representative of the current commercial catch-effort relationships of brown, white, and pink shrimp. The Schaefer model appears to fit the data well, is mathematically easier to use, and generates MSY estimates comparable to those of other models giving similarly good fits. The MSY estimates excluding unreported bait, recreational, and discards, were 85 million pounds of brown shrimp, 38 million pounds of white shrimp, and 14 million pounds of pink shrimp.

Catch and effort data for royal red shrimp are shown in Table 4.7-3; the data are compared to the Generalized Stock Production model in Table 4.7-4, for m equal to 0.5, 1.5, 2.0, and 3.0. As with brown, white, and pink shrimp, all models have fairly similar fits to the data. Despite the similarity, however, the Schaefer model is suggested as representative of the royal red shrimp since they exist in a relatively constant environment in which at least three year classes occupy the same feeding grounds (Anderson, 1971). A MSY of 392,000 pounds of tails annually is predicted. This result is compatible with Roe's estimate of a potential royal red shrimp yield of 425,000 pounds (in Klima, 1976).

Catch and effort estimates for seabob and rock shrimp are shown in Table 4.7-3. An attempt was made to fit the data to the GSP model despite the fact that the reported commercial catch data for seabob and rock shrimp indicate that they are caught and landed incidentally with other shrimp (Tables 4.7-5 and 4.7-6).

The MSY's predicted for rock shrimp are compared in Table 4.7-4. The Schaefer model (GSP, m = 2) was chosen because the predicted relation between catch and effort was similar to other GSP models and because it is mathematically easy to use. The MSY predicted for rock shrimp is 1.1 million pounds of tails annually. This figure cannot be compared to published reports of rock shrimp density; rather it should be viewed with skepticism because the effort estimates for 1971 to 1976 are poor (since the species is an incidental bycatch) and new fishing grounds for these shrimp may be found, as a market for them continues to develop..

Solutions predicting a MSY were not obtained for seabob shrimp. This inability to predict a MSY is due to unreliable effort estimates since seabob shrimp are usually landed incidentally with other shrimp.

Modification of Surplus Yield Estimates for Penaeid Shrimp

The estimates of MSY from surplus production models for penaeid shrimp must be modified to include unreported catch, bait, recreational, and discards. The demonstrated influence of environmental driving forces must also be included. These considerations have much less impact on other species in this plan and need not be considered for them.

Estimates of recreational and bait catches of brown, white, and pink shrimp are listed in Tables 4.7-7 and 4.7-8. In addition, there are important harvesting areas in the gulf where shrimp are caught and discarded. Some estimates of these discarded catches on an average annual basis are:

- Five million pounds (tails) of brown and white shrimp along the Texas coast, June through August (Terry Leary, GMFMC, personal communication, 1978).
- Two to four million pounds (tails) of brown and white shrimp along the Louisiana coast (Charles White, LDWF, personal communication, 1978).
- 316,000 pounds (tails) of pink shrimp in the Dry Tortugas for the 1963-1966 period (Berry and Benton, 1969).

BILLING CODE 3510-22-M

Table 4.7- 3. Reported commercial catch and effort[1] for royal red, sea bob, and rock shrimp in the U.S. Gulf of Mexico (U.S. Dept. of Commerce, 1963-1976).

Year	Royal Red Shrimp		Sea Bob Shrimp		Rock Shrimp	
	CATCH	EFFORT	CATCH	EFFORT	CATCH	EFFORT
	thousand pounds tails	days fished	million pounds tails	days fished	thousand pounds tails	days fished
1963	5.0	8.4	1.14	709	--	--
1964	4.6	6.1	.33	778	--	--
1965	17.0	27.3	.71	790	--	--
1966	23.5	36.5	.48	737	--	--
1967	37.7	88.4	.21	575	--	--
1968	73.5	88.7	.69	2,420	--	--
1969	271.3	506.2	.52	817	--	--
1970	40.9	65.8	2.13	1,905	--	--
1971	64.1	90.7	.32	344	.1	.4
1972	36.6	34.8	1.41	1,635	198.5	167.4
1973	230.8	410.3	2.97	3,548	177.6	299.2
1974	226.9	503.8	4.36	4,350	60.9	58.4
1975	112.6	229.7	4.58	4,580	673.9	463.1
1976	164.2	382.1	.74	1,641	880.0	981.5

[1] Days fished for sea bob and rock shrimp (1963-1975) was calculated by assuming that the fishing effort for a given trip was proportioned directly as the weight of the various species caught and landed. Interviewed days fished estimates were converted to total days fished estimates by using the ratio of interviewed days fished to interviewed trips on an annual basis for royal red, sea bob, and rock shrimp, 1963-1975. Estimates of 1976 days fished for each species were taken directly from NMFS estimates on the Gulf Const Shrimp Data tapes.

BILLING CODE 3510-22-C

Table 4.7–4.—*Comparison of Point Estimates of MSY Generated by fitting[1] Various Forms of the GSP Model[2] to the Reported Commercial Catch Date for Royal Red, Sea Bob, and Rock Shrimp as Reported in Table*

Species and model	Equation predicted	Residual sum of squares[3]	Predicted MSY[4] (1,000 lbs tails)	Predicted f_{opt} (days fished)
Royal Red Shrimp:				
CSP, m=0.5	$Y = .7048\ E\ (1.0723 + .0002529\ E)^{2}$	3,547	751	4,240
CSP, m=1.5	$Y = .6063\ E\ (.9974 - .0001960\ E)^{2}$	3,577	455	1,696
CSP, m=2.0	$Y = .6068\ E - .0002347\ E^{2}$	3,588	392	1,290
CSP, m=3.0	$Y = .1976\ E\ (9.150 - .00598\ E)^{5}$	3,613	352	1,020
Sea Bob Shrimp:				
CSP, m=0.5	$Y = 1.182\ E\ (.2604 + .000969\ E)^{-2}$	*	*	*
CSP, m=1.5	$Y = 0.002538\ E\ (5.086 - .01600\ E)^{2}$	*	*	*
CSP, m=2.0	$Y = .5077\ E + .0001039\ E^{2}$	**	**	**
CSP, m=3.0	No points produced a valid sum of squares			
Rock Shrimp:				
CSP, m=0.5	$Y = .6465\ E\ (.6909 + .0001528\ E)^{-2}$	57,621	1,531	4,522
CSP, m=1.5	$Y = .2054\ E\ (2.525 - .0004214\ E)^{2}$	56,440	1,162	1,997
CSP, m=2.0	$Y = 1.297\ E - .0003889\ E^{2}$	55,970	1,081	1,008
CSP, m=3.0	$Y = .2087\ E\ (37.24 - .01853\ E)^{5}$	55,131	985	1,339

[1] The NLIN procedure in Barr et al. (1976) was used to fit the data to the curvilinear models. All three iterative procedures provided in the NLIN program were used. Only the solution with the lowest residual sum of squares is presented in the "Equation Predicted" column for each species-model combination.

[2] Equation 4.7–1 where catch in thousand pounds and effort is in days fished.

[3] Corrected total sum of squares for royal red shrimp data is 110,949 and for rock shrimp data is 642,499.

[4] Equations predicted for sea bob shrimp data are not theoretically expected and do not predict a MSY.

* Although equations yield solutions, the estimates appear meaningless and plots of residuals indicate that the equations are biased.

** Equation generated is not theoretically expected.

BILLING CODE 3510-22-M

Table 4.7-5. Comparison of sea bob shrimp caught with and without other shrimp in the U.S. Gulf of Mexico (GCSD, 1970-1975).

Year	Sea bob shrimp catch reported as not occurring with other shrimp (million pounds)	Sea bob shrimp catch reported as occurring with other shrimp (million pounds)	Percent total sea bob shrimp catch occurring without other shrimp (%)	Catch of other shrimp reported with sea bob shrimp catch (million pounds)	Ratio sea bob shrimp catch to other shrimp caught
1970	.073	2.06	3.4	11.8	1:5.7
1971	.003	0.25	1.3	11.0	1:43.7
1972	.073	1.36	5.1	17.6	1:12.3
1973	.782	2.19	26.3	8.8	1:4.0
1974	.740	3.62	17.0	13.8	1:3.8
1975	.344	4.24	7.5	19.2	1:4.5

Table 4.7-9. Comparison of the catch of rock shrimp caught with and without other species of shrimp in the U.S. Gulf of Mexico (GCSD, 1971-1975).

Year	Rock shrimp catch reported as not occurring with other shrimp (pounds)	Rock shrimp catch reported as occurring with other shrimp (pounds)	Percent total rock shrimp catch occurring without other shrimp (%)	Catch of other shrimp reported with rock shrimp catch (pounds)	Ratio rock shrimp catch to other shrimp caught
1971	0	113	0	253	1:2.2
1972	3,039	195,461	1.5	349,305	1:1.8
1973	2,915	174,734	1.6	651,469	1:3.7
1974	7,813	53,064	12.8	270,293	1:4.4
1975	11,199	662,723	1.7	828,149	1:1.2

BILLING CODE 3510-22-C

Table 4.7-6.—*Estimates of Annual Recreational Shrimp Catch by Waters Associated With the Five Gulf States*

State	Reported estimate of annual commercial recreational shrimp (1,000 lbs of tails—heads-on)	Assumptions made to convert reported estimates to species catch in tail weight	Estimated annual brown shrimp (1,000 lbs of tails)	Estimated annual white shrimp (1,000 lbs of tails)	Estimated annual pink shrimp (1,000 lbs of tails)
Florida	[5]				[5]
Alabama [1]	257 ± 46	Assume catch is 78% brown shrimp and 22% white shrimp [6]	125	37	
Mississippi [2]	175 ± 9	Assume catch is 86% brown shrimp and 14% white shrimp [6]	94	16	
Louisiana [3]	23,600	Assume catch is 50% brown shrimp and 50% white shrimp [6]	7,329	7,662	
Texas [4]	901 ± 118	Assume catch is 77% brown shrimp and 23% white shrimp [6]	431	134	

[1] Average 1972–1974 (Swingle et al. 1976)
[2] Average 1973–1975 (Weaver and Christmas n.d.)
[3] 1973 estimate (U.S. Army Corps of Engineers n.d.)
[4] 1973 estimate (King 1975).
[5] No data available
[6] Computed from ratio of annual average reported commercial catch of brown shrimp to white shrimp from the area.

Table 4.7-7.—*Estimates of Annual Commercial Bait Shrimp Catch by Waters Associated With the Five Gulf States*

State	Reported estimate of annual commercial bait shrimp catch	Assumptions made to convert reported estimates to species catch in tail weight	Estimated annual brown shrimp catch (1,000 lbs of tails)	Estimated annual white shrimp catch (1,000 lbs of tails)	Estimated annual pink shrimp catch (1,000 lbs of tails)
Florida	74.75 ± 9.5 million shrimp [1]	Assume all shrimp are pink shrimp and 68 tails per pound.			1,099
Alabama	1,544,000 shrimp [2] plus 22,000 pounds shrimp	Assume all shrimp are 68 tails per pound. Assume catch is 78% brown shrimp and 22% white shrimp [6].	28		
Mississippi	43,407 pounds shrimp [3]	Assume catch is 86% brown shrimp and 14% white shrimp [6].	23		
Louisiana	1,529,000 pounds shrimp [4]	Assume catch is 50% brown shrimp and 50% is white shrimp [6].	475	[illegible]	
Texas	2,340,000 pounds shrimp [5]	Assume catch is 77% brown shrimp and 23% white shrimp [6].	1,119	[illegible]	
Estimated total			1,645	857	1,099

[1] Average 1969–1975, Christmas and Etzold (1977)
[2] Estimate for the 1968 period, from Swingle (1972).
[3] Estimate for 1971, from Christmas et al. (1976).
[4] Estimate for 1973, from U.S. Army Corps of Engineers (n.d.) citing a manuscript from the U.S. Fish and Wildlife Service.
[5] Estimate for 1978 from O. H. Farley (NMFS, personal communication 1979).
[6] Computed from ratio of annual average reported commercial catch of brown to white shrimp from the area.

The lack of sufficient data series prevented the development of MSY figures for the recreational, bait, and discard catch. Because estimates of these catches are low in comparison with the commercial MSY figure, they have been rounded off and added to it in the case of each of these three species. This "add-on" is a reasonable approach when as in this case, the amount to be added is a small fraction of the total. An alternate approach would assume trends in annual CPUE for recreational, bait, and discarded catch to be similar to observed commercial CPUE, adjust the point estimates of the catches accordingly, and add them to the commercial catch and effort in each year. While this might be more technically correct, the estimated MSY would be unchanged. The "add-on" approach was only necessary with brown, white, and pink shrimp because estimates for royal red shrimp are not believed to be significant.

The impact of environmental factors on the Gulf brown shrimp catch has been demonstrated. Although the available data for whites and pinks does not allow individual calculation, it is reasonable to expect a very similar impact. This is supported by visual inspection of the figures for Gulf brown shrimp catch and for Louisiana white shrimp catch. Both show a very similar amount of variation in yield, slightly greater than 100 percent between the lowest and highest yields.

In order to estimate a maximum probable yield for all three species, the percentage by which the maximum probable yield estimate for brown shrimp exceeded the surplus production model estimate (137.6 percent) was applied to all three penaeid species. The point estimates for bait, recreational, and discards were then added on. The estimates for the "add-on" do not consider environmental factors and are probably conservative for that reason. The maximum probable catches in millions of pounds of tails for the three penaeid species are:

	Schaefer estimate	Maximum yield considering environmental factors (137.6%)	Recreational	Bait	Discard	Total
Brown Shrimp	85	117	8	2	5	132
White Shrimp	38	52	8	1	3	64
Pink Shrimp	14	19		1		20
Total	137	188	16	4	8	216

These estimates of probable maximum catch, particularly for white and pink shrimp are subject to considerable uncertainty, and are only achievable under optimum environmental conditions with high levels of effort.

The Council will monitor data points throughout the life of the plan in order to obtain data which will allow the derivation of specific formula for species other than brown shrimp.

4.8 *Estimates of Future Stock Conditions*

Although effort is expected to increase, there is no reason to believe that recruitment overfishing will occur. Growth overfishing could occur and decrease the total yield if effort in inshore areas continues to increase. Management measures in the plan should prevent this from occurring and increase yield beyond present levels.

5.0 Catch and Capacity Descriptors

5.1 *Domestic Annual Capacity (DAC)*

Domestic Annual Capacity is considered to be the total physical capacity of the fleet and the processing sector. The basic physical indicators of the U.S. commercial Gulf fleet and its estimated annual capacity to Harvest Gulf shrimp are given in Table 5.2–1 for the 1962–1975 period. The number of commercial boats increased from 1962 to 1968, declining in the early 1970's then increased to 1968 levels in 1975. The number of commercial vessels, average gross tons, average effort index, and total days fished by vessels and boats increased generally over the 1962–1975 period. The increases in days fished by boats and by vessels were similar over this period (Christmas and Etzold, 1977, Fig. 17.)

In 1967 commercial catch and catch per day fished were near record levels. Therefore, 1967 was used to represent the ability of the commercial fishery to land shrimp on an annual and daily basis. The commercial domestic annual capacity in the following years was computed by using 718 pounds per day as an estimate of M_c in Eq. 5.2–2. the actual reported days fished in each year through 1975 were used to estimate the nation's capacity to fish commercially for shrimp in the U.S. Gulf during that year. These estimates are given in Table 5.1–1.

In general, the annual U.S. capacity to harvest shrimp commercially increased over the 1968 to 1975 period from an estimated 138 to 191 million pounds of tails annually. This increase in Domestic Annual Capacity reflects a general increase in the desire and physical facilities to harvest Gulf shrimp. In addition, recreational and bait shrimp catches are expected to remain at least at current levels. These levels have been estimated as 16 and four million pounds of tails, respectively.

The estimated total Domestic Annual Capacity to harvest U.S. Gulf brown, white and pink shrimp is 211 million pounds of tails annually, as of 1975. *Estimated capacity for 1980 and 1981 is 233 million pounds and 240 million pounds, respectively. The DAC for royal red shrimp is estimated to be 270,000 pounds.*

5.2 *Data and Analytical Approach*

Catch (Y) can be viewed as

Eq. 5.2–1

$$Y = f(P) \cdot E$$

where f is the catchability coefficient; P, the population density and E, the fishing effort. The population density will depend in large part upon prevalent environmental conditions. The expected fishing effort will be the summation of physical and economic parameters limiting fishing effort, as well as physical and economic parameters limiting the landing, storage, and consumption of shrimp.

Domestic annual capcity (DAC) can be defined as

Eq. 5.2–2

$$DAC = E \times M_c$$

where E is annual days fished and M_c is the average maximum catch per day fished that could be harvested, landed, processed, and later consumed, for that annual period of fishing effort.

In estimating the DAC of the Gulf shrimp fishery, the largest annual catch per day (during a peak year) for the 1963 to 1975 period and the actual number of days fished in each year was used.

After 1975 the annual number of days fished (E) was estimated by a linear regression of days fished on year for 1968–1975.

Table 5.1.1.—*Basic Catch and Capacity Indicators of the Reported Commercial U.S. Gulf Fleet and Estimates of Domestic Annual Capacity [3] to Harvest Shrimp*

Year	Number of reported commercial boats [1]	Number of reported commercial vessels [1]	Average vessel gross tons [1] (tons)	Average effort index of vessels [2]	Reported commercial catch [2] (million pounds)	Reported days fished [2] (thousand days)	Reported catch per days fished [2] (pounds per day)	Domestic annual capacity (DAC) [3] (million pounds)	Difference between DAC and harvest (million pounds)	Percent DAC not attained (percent)
1962	3,927	2,600	41.9	1.63	69.9	146.5	477.1			
1963	4,481	2,697	41[illegible]	1.61	110.7	121.4	731.1			
1964	4,360	2,782	42.0	1.63	95.9	169.8	546.7			
1965	4,785	2,849	42.7	1.65	107.1	170.4	628.5			
1966	4,797	2,942	44.9	1.67	103.7	175.9	589.5			
1967	4,983	3,146	[illegible]	1.74	130.7	182.1	717.7			
1968	5,109	3,430	52.5	[illegible]	113.9	191.5	594.7	137.4	23.5	17
1969	4,817	3,569	53.7	1.85	118.3	200.4	[illegible]	143.8	25.5	17
1970	4,495	3,579	[illegible]	1.85	136.3	200.0	[illegible]	143.5	7.2	5
1971	4,828	3,487	57.8	1.89	134.1	[illegible]	[illegible]	147.0	13.1	[illegible]
1972	4,500	3,683	59.2	1.93	132.1	[illegible]	577.1	164.3	32.2	20
1973	4,723	4,091	59.9	1.93	104.7	[illegible]	539.9	170.8	66.1	39
1974	4,589	4,785	61.5	1.84	106.9	222.7	480.0	159.8	52.9	33
1975	5,054	3,780	64.0		[illegible]	[illegible]	[illegible]	191.3	91.8	[illegible]

[1] Griffin (1978).
[2] Christmas and Etzold 1977.
[3] Computed as DAC—$E \times M_c$ where DAC equals domestic annual capacity, E is the observed days fished, and M_c is the maximum observed catch per day fished for a peak catch year during the period of observation.

$RE = (-17958.6) + 9.22\ (year)\ r^2 = .81$

The shrimp catch of the Gulf vessel fleet in any year can be expressed by the following identity:

$Yv = V\ (Dv/V)\ (E/Dv)\ (Yv/E)$ Eq. 5.2.3

where Yv indicates the pounds caught by vessels, V represents the number of vessels, Dv is the total number of days fished by the vessel fleet, and E is total fishing effort of the vessel fleet.

Similarly, the shrimp catch by Gulf boats in any year can be expressed as

$Yb = B\ (Db/B)\ (Yb/Db)$ Eq. 5.2–4

where Yb represents the pounds landed by boats, B the number of boats, and Db the number of days fished by all shrimp boats.

5.3 Expected Domestic Annual Harvest (DAH)

The Domestic Annual Harvest is the record and projections of atual shrimp harvest.

5.3.1 Expected DAH for the Combined Species

DAH was estimated from trends in the reported commercial harvest and from point estimates derived for recreational, bait, and discarded catches. Trends in commerical harvest and effort were examined by boat data and vessel data separately.

Catch and effort statistics for commercial vessels are listed in Table 5.3–1. The commercial vessels fleet has had no statistically significant linear trend in days fished per vessel (Dv/V) or catch per unit of fishing effort (Yv/E). Rather these seemed to have exhibited averages of

38.1 days fished per vessel, and
367.1 pounds (tails) per unit effort.

The number of commerical vessels (V) and the unit effort per day fished (E/Dv) of these vessels have had statistically significant linear increases from 1962 to 1974 that are represented by the relationships

$V = 2461 + 117\ YR\ (R^2 = .93)$ Eq. 5.3–1
$E/Dv = 1.57 + .029\ YR\ (R^2 = .86)$ Eq. 5.3–2

where YR is the calendar year minus 1961

The expected commercial vessel catch in 1980 and 1981 are estimated (by substituting the estimated values for Dv/Y, Yv/E, V, and E/Dv into Eq. 5.1–3) to be 139 and 144 million pounds of tails.

Catch and days fished statistics for commercial boats are listed in Table 5.3–1. The commercial boat fleet has not exhibited statistically significant linear trends in number of boats (B) or catch per day fished (Yb/Db). The averages over the 1962–1974 period have been 4,645 boats and 503 pounds per day fished. The number of days fished per boat (Db/B) has increased significantly (1962–1974).

BILLING CODE 3510-22-M

Table 5.3-1. Parameters used to estimate expected domestic annual harvest for the reported commercial shrimp fishery.

YEAR	VESSEL CHARACTERISTICS				BOATS		
	number[1] of vessels	days fished[2] per vessel	ratio unit[3] effort to days fished	pounds[3] per unit effort	number[1] of boats	days fished[2] per boat	pounds per[3] days fished
62	2600	34.0	1.63	315	3927	14.8	434
63	2697	41.9	1.61	423	4481	8.6	865
64	2782	41.1	1.63	381	4360	12.7	424
65	2849	39.9	1.65	427	4785	11.8	450
66	2942	38.6	1.67	411	4797	13.0	395
67	3146	36.9	1.74	494	4983	13.3	463
68	3430	35.4	1.80	383	5109	13.7	427
69	3569	41.8	1.85	301	4817	10.9	675
70	3579	37.6	1.85	386	4495	14.5	613
71	3487	39.3	1.89	352	4828	14.1	626
72	3683	39.9	1.93	333	4500	18.2	459
73	4091	34.2	1.93	263	4723	20.7	343
74	3785	35.0	1.84	303	4589	19.7	363

[1]From Table 3.5-8.

[2]Data on days fished from Table 3.5-7.

[3]From Christmas and Etzold (1977).

BILLING CODE 3510-22-C

Db/B=9.72+.66 (Time) (R^{2}=.59 Eq. 5.3–3

The expected commecial boat catch in 1980 and 1981 are estimated (by substituting the estimated values for B, Yb/Db, and Db/B into Eq. 5.1–4) to be 52 and 54 million pounds of tails.

The expected reported commercial catches for 1980 and 1981 are 191 and 198 million pounds. Bait and recreational catches are not expected to decline from 1963–1967 levels. A conservative estimate of expected recreational catch is 16 million pounds (tails) and four million pounds (tails) for the expected bait shrimp. *The total expected domestic catches for 1980 and 1981 are 211 million pounds and 218 million pounds.*

These estimates of expected harvest must be viewed with considerable caution because of limitations inherent in the formulas or model being used. The periods for which catch is estimated are six or more years beyond the limits of the available data series. Such a large time extension goes far beyond the predictive ability of the model. The model assumes constant CPUE and increases in catch with increasing effort. Catch per unit effort was assumed constant because the trend between 1962 and 1974 was not statistically significant. However, the data does indicate a downward trend as effort has increased. Because the catch is approaching the maximum available in a given year, further increases in effort must, inherently, decrease CPUE. When the data becomes available, the estimate of expected harvest may be reduced if CPUE is declining. The Council will closely monitor the fishery to establish the reliability of these estimates.

5.3.2 Expected DAH of Royal Red Shrimp

Royal red shrimp deserve special attention because these deep-water shrimp were subject to a directed fishery. Available data indicated they were underexploited.

In this case annual catch was regressed against year by simple linear regression. The relationship implies that as time progresses, catch will increase. This has some validity in that

- Catch has tended to increase with time (1963–1976);
- The major shrimp resources of the Gulf are being harvested at levels approximating MSY; and
- There has been a general increase in effort in the U.S. Gulf shrimp fishery despite the fact that the major stocks are being harvested at levels approximating MSY.

A simple linear increase is not expected to continue as catch of this limited resource approaches its MSY. The relationship derived is

DAH of royal red shrimp = −890+14.2 (year) Eq. 5.3–4
(R^{2}=.41, n=8)

where year is in the form 63, 64, etc. *The expected domestic annual harvest of royal red shrimp in 1980 and 1981 is 246,000 pounds and 260,000 pounds, respectively.* Eq. 5.3–4 is considered a crude estimator and should be reevaluated as new data are available.

5.4 Domestic Annual Processing Capacity (DAP)

Cato (1975) reported that 1970 shrimp landings in Louisiana, Texas, Alabama, Mississippi, and Florida represented 97, 84, 76, 57, and 35 percent respectively of the raw shrimp processed in each state. There have been no subsequent studies to identify more recent conditions. If similar figures apply after 1970, then the capacity to process domestic landings exceeds domestic landings. The deficit is overcome with shrimp imported from other states and foreign nations.

A 1972 (Alvarez) survey of fifteen Florida shrimp processors who accounted for 85 percent of the state's production revealed that the industry was utilizing only 55 percent of total plant capacity. This poor utilization of plant capacity occurred despite the use of significant imports from other states and countries. On the average, firms in the "small" class used more of their capacity than did firms in the "medium" and "large" classes. The same relationship held true between the "medium" class and the "large" class. A shortage of raw shrimp for processing was responsible for the excess capacity.

Prochaska and Andrew (1974) point out that the entire southeast is deficient in raw shrimp supplies in comparison with processing capacity. A detailed analysis of the situation in Florida reveals that shortages of raw shrimp result in an increasing share of processed shrimp being produced by a few firms.

While excess capacity is frequently found in an industry, the available information here clearly leads to the conclusion that *Gulf shrimp processing capacity is far in excess of the region's domestic landings.*

The Florida studies adequately addressed shrimp processing functions similar to those in most Gulf states. However, the absence of information on shrimp canning operations means that the results cannot completely describe the major Gulf shrimp canning industry. Capacity measures for the canning industry located in Louisiana and Mississippi were developed from key machinery capacities and a specified number of operating days per year; the production year was based on 147 operating days during the approximate 180 days of the inshore seasons. Average daily plant capacity was estimated to be 4,400 standard cases containing 24 cans, each four and one-half ounces. When these figures are applied to the 14 shrimp canners reporting production in 1978, a maximum capacity of 9,055,200 standard cases is derived. In the three most recent years Gulf shrimp canners produced 1,618,322 (1976), 2,104,625 (1977), and 1,464,722 (1978) standard cases (U.S. Department of Commerce 1979). Excess capacity in shrimp canning operations exists for a number of reasons, among which are the necessity of designing plants to handle peak volumes of fresh shrimp, recent high ex-vessel prices, and cash-flow problems related to the difficulty of financing inventories.

5.4.1 Data Which Shrimp Processors Must Submit to the Secretary of Commerce to Calculate DAP

Shrimp processors in the Gulf of Mexico participate in data collection programs of varied natures. Most states have some reporting requirements of processors; these requirements must be recognized prior to the development of mandatory data systems for the Gulf Shrimp Management Plan. The comparability of the requirements among the states and the information collected through the voluntary programs of the National Marine Fisheries Service must also be considered.

Reporting requirements of the Gulf states are identified in section 3.3.1, Management Institutions, Policies, and Jurisdictions. A brief summary for each state follows:

Alabama—Seafood dealers are required to make monthly reports of the names and addresses of persons from or to whom fish, seafood, or other saltwater products of the state are purchased or sold, the quantity purchased from or sold to each vendor or buyer, and the date of each transaction. The data reporting requirements are not well accepted.

Florida—Individuals harvesting or buying shrimp for canning, drying, or shipping must state the number of barrels of shrimp caught or sold each month and any other information FDNR may require. Wholesale dealers make quarterly reports on the number of pounds purchased from commercial

fishermen but this is not applied or enforced as to purchases of shrimp.

Mississippi—Processing or landing firms are the points at which data on harvesting activities are reported.

Louisiana—All shrimp processing plants and dealers must keep records of the date, quantity, and point of origin of each lot of shrimp received. Retailers must complete a quarterly report on the amount of shrimp purchased and the name and license number of the seller.

Texas—No reporting on processing activities is required. Anyone who purchases shrimp from the fisherman for resale must report monthly.

Shrimp processors, ranging from dealers to canners, frequently provide information to the National Marine Fisheries Service on a variety of topics. The amount of product handled, its value, frozen shrimp holdings, and the number of seasonal and full-time employees are all reported to the public through the NMFS Current Fisheries Statistics publication series and Market News Reports. The information collection procedure involves voluntary contribution of statistics. Although there may be previously unmeasured problems with the representativeness of the statistics, they do identify poundage, locations, disposition, and prices. In the majority of instances species identification is not maintained beyond the dealer level.

The NMFS information collection effort, other U.S. government surveys on economic activities of businesses, and the reporting requirements of some states do not make for a climate conducive to the successful addition of another information system. Thus, the management objectives concerning the processing sector that are proposed here require no additional information collecting programs. Then too, many shrimp processors are involved in the processing of other species, and, until a systematic program of information collection on processing activities is developed, a species approach to data collection could create a chaotic situation. Instead, emphasis should be placed on improving the coverage, frequency, and currency of the existing voluntary system. When developed, comprehensive information systems on processing activities should show their consideration of the statistics that reflect processing capacity.

5.5 Additions to DAH to Account for Joint Ventures

The domestic market for shrimp and shrimp products has been sufficiently strong historically to attract significant quantities of imported shrimp. The economic climate has been such that no incentive exists for the transfer at sea of U.S. shrimp caught in the FCZ to flag vessels of other nations. In fact, domestically based shrimpers have sought harvesting arrangements in foreign waters to secure increased supplies of shrimp. The catch by U.S. flag vessels off Central and South America was reported to be 14 million pounds annually worth about $18 million (G.A.O., 1976). However, there is information available which indicates that the practice as relates to Mexican waters decreased significantly between 1962 and 1974 (Griffin, 1976).

The shrimping activities of foreign nations in the FCZ have been quite limited. From 1971 to 1975 harvest by Cuba and Mexico in the FCZ averaged slightly more than one million pounds (G.A.O., 1976). Thus, there has been little spatial interaction in the FCZ between major shrimp harvesting nations on which a transfer business could be based.

The lack of historical occurrence of the transfer of shrimp to foreign vessels and a domestic market strong enough to attract approximately 50 percent (Sec. 3.5.1.3) of domestic needs from imported shrimp lead to the conclusion that transfer are unlikely to occur. The market conditions ar such that this conclusion should have merit over the next five years. While this conclusion relates to shrimp it is possible that the transfer of incidental catch could be arranged. The domestic market condition for the bulk of the incidental catch is essentially the antithesis of that for shrimp. Transfer of some or all of the incidental catch of cooperating vessels to foreign vessels may become an avenue to improve the utilization of incidental catch.

6.0 Optimum Yield

A program of improved management as specified in this plan is expected to increase the yield from the fishery which is not operating at optimum harvest levels. Basic factors limiting the attainment of optimum harvest include:

(1) Conflict between user groups as to area and size of shrimp to be harvested.

(2) Discarding of shrimp through the wasteful process of culling.

(3) Continuing decline in quality and quantity of estuarine habitat.

(4) Lack of comprehensive, coordinated, and easily ascertainable management authorities over shrimp resources throughout their ranges.

(5) Conflicts with other fisheries such as the stone crab fishery in southern Florida, groundfish fishery in the north central Gulf, and the Gulf's reef fish fishery.

(6) Incidental capture of sea turtles.

(7) Loss of gear and trawling grounds due to man-made underwater obstructions.

(8) Partial lack of the basic data needed for management.

Specific objectives and measures to alleviate these problems and to attain OY levels are suggested in Section 8.0. None of these measures are likely to result in a reduction in present catch levels; some are likely to increase yield in a manner consistent with the National Standards for Fishery Conservation and Management.

6.1 Determination of Optimum Yield (OY)

Optimum yield is defined as "the amount of fish

(A) which will provide the greatest overall benefit to the nation, with particular reference to food production and recreational opportunities; and

(B) which is prescribed as such on the basis of the maximum sustainable yield from such fishery, as modified by any relevant economic, social, or ecological factor."

It is the intent of this plan in conformance with the first of the national standards to prevent overfishing while achieving, on a continuing basis, the optimum yield. The shrimp fishery, however, is unique for several reasons. Most shrimp harvested are about six months old, and few survive beyond a year. Because they are prolific spawners, the quantity of one year's brood stock is not related to the abundance of the next year's population.

Natural environmental forces have a dramatic and overriding effect on the annual yields of brown, white, and pink shrimp (Section 4.1). Because of their great fluctuation and the high spawning-ability of shrimp, a predetermined classical MSY is not a good indicator to use in determining if overfishing will occur. For example, the classical MSY levels were exceeded in four years from 1966 to 1975, years of favorable environmental conditions.

For these species of shrimp the optimum yield essentially is all of the shrimp that can be harvested from the stock given certain management conditions. *Recruitment* overfishing has not will not occur with the use of present technology and fishing gear. Management measures proposed in Section 8 are intended to prevent *growth* overfishing where it may presently occur, thus achieving a higher yield from a same level of recruitment.

For the purpose of this plan OY should be regarded as a goal to be achieved and exceed under favorable environmental conditions without fear

of damage to future stocks. It should not be considered to be a celling above which recruitment overfishing occurs.

6.2 Specification of Optimum Yield

In deriving OY from MSY as adjusted by environmental conditions, the Council paid close attention to the following criteria:

1. Provide each associated processing industry with the count size of the shrimp resource most suited to the several needs.
2. Prevent discrimination among fishermen based on boat/vessel size.
3. Eliminate conditions wherein boat/vessels would shrimp in the FCZ and claim the landings came from the territorial sea or inland waters and vice versa, depending on location of open and/or closed waters.
4. Protect the resource during specific periods to improve yield.

6.2.1 Shrimp Other Than Royal Red Shrimp

OY is determined to be: All the shrimp that can be taken during open seasons in permissible areas in a given fishing year with existing gear and technology. The Council has determined that, because of the annual nature of the resource, a numerical value for OY cannot be calculated for any given year until the environmental factors can be determined and evaluated. However, under optimum environmental conditions and maximum effort, the maximum probable catch for brown, white and pink shrimp is estimated to be 216 million pounds of tails. Fishing, however, will not be stopped when this numerical estimate is reached.

The Council has also determined that adjustments to OY need not be made yearly as economic, bilogical, and technological factors prevent the taking of sufficient shrimp during a single year to harm the next year's resource size. The Council will monitor closely the appropriate factors of the management regime established by the plan and, in particular, the environmental factors surrounding the determination of MSY. Should conditions warrant, the Council will provide the information to the Secretary of Commerce and a new MSY/OY relationship will be established through rule making.

6.2.2 Royal Red Shrimp

Royal red shrimp differ from brown, white, and pink shrimp in that they are not estuarine dependent but exist in a relatively constant environment in the deeper waters of the Gulf (100 to 300 fathoms). They are not an annual crop but are harvested from grounds believed to contain at least five year classes. Thus, they conform more closely to a classical Schaefer-type fishery. For this reason, the optimum yield of royal red shrimp should be the total pounds of royal red shrimp which can be harvested without biologically overfishing this resource. An estimate of the allowable catch is 392,000 pounds (tails). These figures should be reassessed as new annual catch-effort data become available. OY is set at this figure and fishing will stop when it is reached.

6.3 Alternatives to Optimum Yield Considered and Rejected

6.3.1 Optimum Yield for Brown, White, and Pink Shrimp to be Set at MSY

Setting OY for these three species at MSY or 165 million pounds of tails annually would have reduced the 1977 catch by 27 million pounds. Because this fishery can support a yield of all that can be harvested with present gear and technology, setting a lower level of harvest would result in a wasted resource in an annual crop. The loss of 27 million pounds of shrimp at 1976 wholesale prices would have resulted in a loss $75.3 million to the industry. No benefit from stockpiled shrimp nor an increased number of recruits the following season would result from taking less than is available.

6.3.2 Fishing to Stop When Optimum Yield is Reached for Brown, White, and Pink Shrimp

The intent of the first National Standard is to achieve OY while preventing overfishing the stocks. If the stocks cannot be overfished, any reduction of catch from the available, harvestable stock is a direct loss to the fishing industry.

6.3.3 Optimum Yield for Royal Red Shrimp to be Set Above MSY

The fishery for royal red shrimp differs substantially from that for brown, white and pink shrimp. It is composed of a slower growing species with up to five year classes in the catch. Little is known about the population dynamics of royal red shrimp, and recruitment overfishing may be possible. The establishment of OY above MSY could result in overfishing and stock damage.

6.3.4 Optimum Yield for Royal Red Shrimp to be Set at MSY With Fishing to be Permitted to Exceed OY

Exceeding the catch of OY equal to MSY (as in alternative 6.3.3) could result in biological overfishing. This alternative was rejected for a more conservative approach in an area of limited data.

6.3.5 Optimum Yield for Royal Red Shrimp to be Set Below MSY

This alternative for a multiyear class fishery would have the result of rebuilding the stock. Royal red shrimp have, however, been fished well below MSY and may be considered to be an underutilized resource. No rebuilding is necessary at this time.

6.3.6 Optimum Yield Set at Higher Estimate of ABC

An expected range of the seasonally determined estimates for Acceptable Biological Catch when the upper range of variation in catch data was considered as an ABC for each fishery; the following ranges were proposed:

brown shrimp—51 to 107 million pounds of tails annually.
white shrimp—37 to 59 million pounds of tails annually.
pink shrimp—11 to 16 million pounds of tails annually.

The Council considered determining that OY for these species should be at the upper level of the expected ABC ranges:

brown shrimp—107 million pounds of tails annually.
white shrimp—59 million pounds of tails annually.
pink shrimp—16 million pounds of tails annually.

for a total of 182 million pounds of tails annually. This option was rejected for two reasons. It was based only on past recorded landings with little basis in the biology of the stocks. This OY can be and has been (1977, 1978) exceeded when environmental conditions are favorable and effort is high. There is no evidence that exceeding this OY option had an adverse impact on recruitment in subsequent years.

7.0 Total Allowable Level of Foreign Fishing (TALFF)

7.1 Brown, White, and Pink Shrimp

There is no surplus available for a TALFF in the fisheries for brown, white, and pink shrimp. Domestic Annual Harvesting Capacity for brown, white and pink shrimp is estimated to be 234 million pounds in 1980 and 240 million pounds in 1981. Expected Domestic Annual Harvest for 1980 and 1981 is estimated at 211 and 218 million pounds of tails; OY is designated to be all the shrimp that can be harvested in allowable times and areas under present conditions. Major stocks are currently being harvested at optimum yield levels by the U.S. shrimp fleet.

7.2 Royal Red Shrimp

It is generally believed that royal red shrimp are not being harvested at their

OY level of 392,000 pounds of tails annually. Annually reported commercial catch has never exceeded 270,000 pounds of tails (1963–1975); expected domestic harvest for 1980 and 1981 are 246,000 and 260,000 pounds of tails. A foreign TALFF of some 146,000 pounds in 1980 and 132,000 pounds in 1981 is, therefore, estimated to be available. Catch trends should be reinvestigated, however, as new data become available.

Further domestic development of this fishery is hampered by the great depth at which the resource exists and the specialized gear required to fish it, high production costs, and shrinkage of the product during processing.

7.3 Seabob and Rock Shrimp

Data available on seabob and rock shrimp indicate that

- They are caught incidentally to other shrimp—seabob shrimp mainly with white shrimp and rock shrimp with pink shrimp;
- They are not being harvested at MSY levels (1963–1976);
- The catch has increased markedly in recent years (1971–1976).

Seabobs and rock shrimp are caught incidentally with white and pink shrimp respectively. There is no surplus of white and pink shrimp from the domestic fishery available for foreign fishing. Therefore, in order to prevent foreign harvest of nonsurplus species, no TALFF for seabobs or rock shrimp is provided.

8.0 Management Regime

8.1 Areas and Stocks Involved

The fishery being addressed is comprised of the species listed below and occurs in the area of jurisdiction of the Gulf of Mexico Fishery Management Council as well as in the territorial seas adjacent thereto and the associated bays, inlets, wetlands, and upland areas as appropriate:

Brown shrimp (*Penaeus aztecus* Ives)
White shrimp (*Penaeus setiferus Linnaeus)*
Pink shrimp (*Penaeus duorarum* Burkenroad)
Royal red shrimp (*Hymenopenaeus robustus* Smith)
Seabobs (*Xiphopeneus kroyeri* Heller) incidental bycatch
Rock shrimp (*Sicyonia brevirostris* Stimpton) incidental bycatch

The Council recognizes that the stock and the fishery extend across political and international boundaries. While it is the intent to manage the stock as a unit, the authority of the Council is restricted to the development of plans and proposal of management measures in the United States' FCZ in the Gulf of Mexico.

An arrangement for joint management of common stocks with Mexico would require a bilateral agreement. Negotiations with Mexico to renew the U.S./Mexico bilateral are underway; however, a mechanism for joint management does not seem likely for the near future. With the present lack of such an international management mechanism this plan addresses only the stock in U.S. waters and makes the assumption that shrimp movement across the border flows equally in both directions.

8.2 Management Unit and Period

8.2.1 Management Unit

This management unit is comprised of brown, white, pink, royal red, seabobs and rock shrimps in the area of jurisdiction of the Gulf of Mexico Fishery Management Council as well as the territorial seas adjacent thereto and the associated bays, inlets, wetlands and upland areas as appropriate. Federal implementation of regulations will occur only in the FCZ. On the east coast of the United States a natural biological break in fauna is found on the southeast coast of Florida. On the western edge the international boundary between Mexico and the U.S. serves as a political break.

8.2.2 Management Period

The Council has specified that the management year for all species except royal red should begin May 1 and extend through April 30 annually. The beginning of the period coincides with a time of low harvest in all of the major species of the management unit. The fishery year for royal red shrimp will be the calendar year because of the TALFF associated with the fishery.

8.3 Problems in the Fishery

The Council has identified the following problems associated with the fishery and the present management regime and has prepared the plan objectives to address and alleviate them. In a free access fishery a management regime to maximize protein yield and economic return of the fisherman is of importance.

(1) Conflict among user groups as to area and size at which shrimp are to be harvested.

(2) Discard of shrimp through the wasteful practice of culling.

(3) The continuing decline in the quality and quantity of estuarine and associated inland habitats.

(4) Lack of comprehensive, coordinated and easily ascertainable management authorities over shrimp resources throughout their ranges.

(5) Conflicts with other fisheries such as the stone crab fishery in southern Florida, the groundfish fishery of the north central Gulf, and the Gulf's reef fish fishery.

(6) Incidental capture of sea turtles.

(7) Loss of gear and trawling grounds due to man-made underwater obstructions.

(8) Partial lack of basic data needed for management.

8.4 Objectives

8.4.1 Specific Management Objectives

The following are the specific management objectives of this plan and are proposed to the appropriate authorities in charge of Gulf of Mexico shrimp resources. These objectives are to:

(1) Optimize the yield from shrimp recruited to the fishery.

(2) Encourage habitat protection measures to prevent undue loss of shrimp habitat.

(3) Coordinate the development of shrimp management measures by the Gulf of Mexico Fishery Management Council with the shrimp management programs of the several States, where feasible.

(4) Promote consistency with the Endangered Species Act and Marine Mammal Protection Act.

(5) Minimize the incidental capture of finfish by shrimpers, when appropriate.

(6) Minimize conflicts between shrimp and stone crab fishermen.

(7) Minimize adverse effects of underwater obstructions to shrimp trawling.

(8) Provide for a statistical reporting system.

8.4.2 Alternative Objectives

Alternative management objectives were considered by the Council and rejected for the reasons indicated:

Alternative 1.

Establish the preferred size at which shrimp will be harvested. In establishing this size provide a reasonable accommodation for the conflicting interests of the various groups which concurrently compete for the shrimp resources in order to prevent the economic dislocation of particular groups as a result of measures adopted.

Rationale: The Council did not establish one preferred size for harvest because, based on economic and sociological factors, this size varies regionally. The variation is due to the local vessel size composition of the fleet and prevailing methods of processing shrimp. The establishment of one preferred size throughout the Gulf and the regulation of catch to that size would have severely disrupted the economy and work force of those areas where the fishery is directed to a different size.

Alternative 2.

Define and restrict shrimping in areas where preferred size shrimp are not normally taken on a seasonal or yearly basis.

Rationale: This alternative was rejected as a specific management objective because its scope was narrow. Its goal is included under the selected objective number 1.

Alternative 3.

Minimize the incidental catch and the adverse effects of the incidental catch of sea turtles by shrimpers.

Rationale: The wording of this alternative was revised to become objective number 4.

Alternative 4.

Establish a preferred level of capitalization.

Rationale: There is no economic evidence to suggest that the shrimp fishery differs from the classic example of a fishery near open access equilibrium. (Open access equilibrium refers to firms having free access to the fishery, generating just enough revenue to cover total costs over a long period of time, and entering or exiting the fishery in the short run with prevailing economic conditions.) Reductions in fishing effort are unlikely to result in anything other than small decreases in shrimp landings and a loss of jobs to fishermen and shore support personnel.

Alternative 5.

Insure continuance of the resource.

Rationale: Objective number 1 includes this option. Recruitment overfishing is not a problem in this fishery.

8.5 Management Measures and Rationale

8.5.1 Management Measures Considered and Adopted

Management measures considered by the Gulf of Mexico Fishery Management Council and suggested for incorporation into a shrimp management plan are discussed below. Some of these management measures are recommended for federal implementation by the U.S. Department of Commerce. Other measures are either administrative policies adopted by the GMFMC or are recommended for consideration by the various States and other agencies. Other measures considered, but not recommended, are documented in Section 8.5.2 and in the notes of the various meetings conducted to develop and evaluate the draft plan. The recommended measures are grouped with the objective addressed.

8.5.1.1 Objective 1: Optimize the Yield of Shrimp Recruited to the Fishery

Measure 1: Establish a cooperative permanent closure with the State of Florida and the U.S. Department of Commerce of the area delineated in Table 8.3–1 to protect small pink shrimp until they have generally reached a size range larger than 69 tails to the pound. The area to be closed is to be denoted as the "Tortugas Shrimp Sanctuary" and is generally represented by the line drawn in Figure 8.3–1.

The historic Tortugas Shrimp Sanctuary as established by the State of Florida has been modified slightly as the result of public hearings to reduce its size. This modification will allow shrimping in some deeper areas containing larger shrimp north of Smith and New Ground Shoals in the vicinity of Key West.

The U.S. Department of Commerce will close that portion of the FCZ within the area defined as the Tortugas Shrimp Sanctuary to all shrimping. All shrimp which are caught in open waters of the FCZ may be retained.

The State of Florida is encouraged to continue its present restrictions on shrimping in the area and to consider the retention of all shrimp which are caught in open waters, as well as establishing a sampling program to evaluate the effectiveness of the closed area.

Rationale: This measure would essentially re-establish most of the old Tortugas shrimp nursery area which until recently has served as a sanctuary for pink shrimp recruited to the Tortugas and Sanibel shrimping grounds. (The area within the FCZ can currently be shrimped by non-Floridians because Florida does not have jurisdiction.) Currently, the minimum legal size in Florida is 70 tails to the pound. No more than five percent of the catch can be of smaller-sized shrimp.

This measure would largely recreate the old Tortugas Shrimp Sanctuary; its proposal is based on available biological data and on the fact that a mature fishery appears to be dependent on it. Lindner (1966) and Berry (1970) report growth and mortality data which indicate that pink shrimp yield will be maximized if harvest begins only when shrimp are larger than the minimum legal size for harvest in Florida.

Costello and Allen (1965) summarized extensive sampling and mark and recapture data which indicate that estuaries within the Tortugas Shrimp Sanctuary are important nursery areas for post-larval and juvenile pink shrimp eventually recruited to the Tortugas and Sanibel beds. Yokel, et al. (1969) observed that the average shrimp leaving the Everglades nursery area is in the 300 to 200 tails to the pound range. Iverson, et al. (1960), sampling extensively in the southern portion of the Tortugas Shrimp Sanctuary area and in the southern portion of the Tortugas shrimping grounds, observed a relationship between size of shrimp and depth of water.

Table 8.3–2 was constructed using these observed relationships and McCoy's (1972) carapace length-weight relationships. The table indicates that at 10 fathoms shrimp will average 68 tails to the pound, and at 13 fathoms they will average 54 tails to the pound. Essentially, none of the proposed sanctuary area is deeper than 13 fathoms, and most of it is shallower than ten fathoms. Thus it should protect shrimp until they have reached an average count of around 70 tails to the pound. However, given the variation in size of shrimp according to depth reported in Iverson, etal. (1960), it does not seem likely that the sanctuary will protect shrimp until they have reached the current legal mix in Florida of no more than five percent of the catch consisting of shrimp 70 or more tails to the pound. For example, Table 8.3–2 indicates that at 13 fathoms the catch will average around 54 tails to the pound. A spot check of the reported commercial catch (U.S. Department of Commerce, Gulf Coast Shrimp Data, Annual Summaries for 1972 and 1974) shows that catch in the 11 to 15 fathom interval of the Dry Tortugas does have a peak in the 51 to 57 tails to the pound range. However, although considerable pounds of shrimp larger than this count were reported, only minor quantities of smaller shrimp were reported as landed. This apparent discrepancy in size distribution may relate to a possible discard of large quantities of undersized pink shrimp.

Table 8.3–1. Delineation of suggested Tortugas Shrimp Sanctuary

The Tortugas Shrimp Sanctuary is described as follows:

(1) Begin at Coon Key Light in Collier County (N);

(2) Thence proceed on a straight line to a point (F) located at 24° 50.7′ north latitude and 81° 51.3′ west latitude;

(3) Thence proceed on a straight line to New Grounds Shoal Light (G);

(4) Thence proceed on a straight line to Rebecca Shoals Light (H);

(5) Thence proceed on a straight line to R. B. Bell Buoy (I);

(6) Thence proceed on a straight line to Cosgrove Shoal Light (J);

(7) Thence proceed on a straight line to Sand Key Light (K); thence proceed northerly to the abandoned lighthouse located in the southwest portion of Key West (L);

(8) Thence along the south and east meandered shoreline of the Florida Keys and the connecting viaducts between said Keys to 80° 30.00′ west longitude; thence north until a point on the mainland is reached;

(9) Thence proceed west and north along the coast of the mainland of Florida until a point is reached which is located due north of the aforementioned Coon Key Light located in Collier County;

(10) Thence due south to Coon Key Light, the point of beginning.

BILLING CODE 3510-22-M

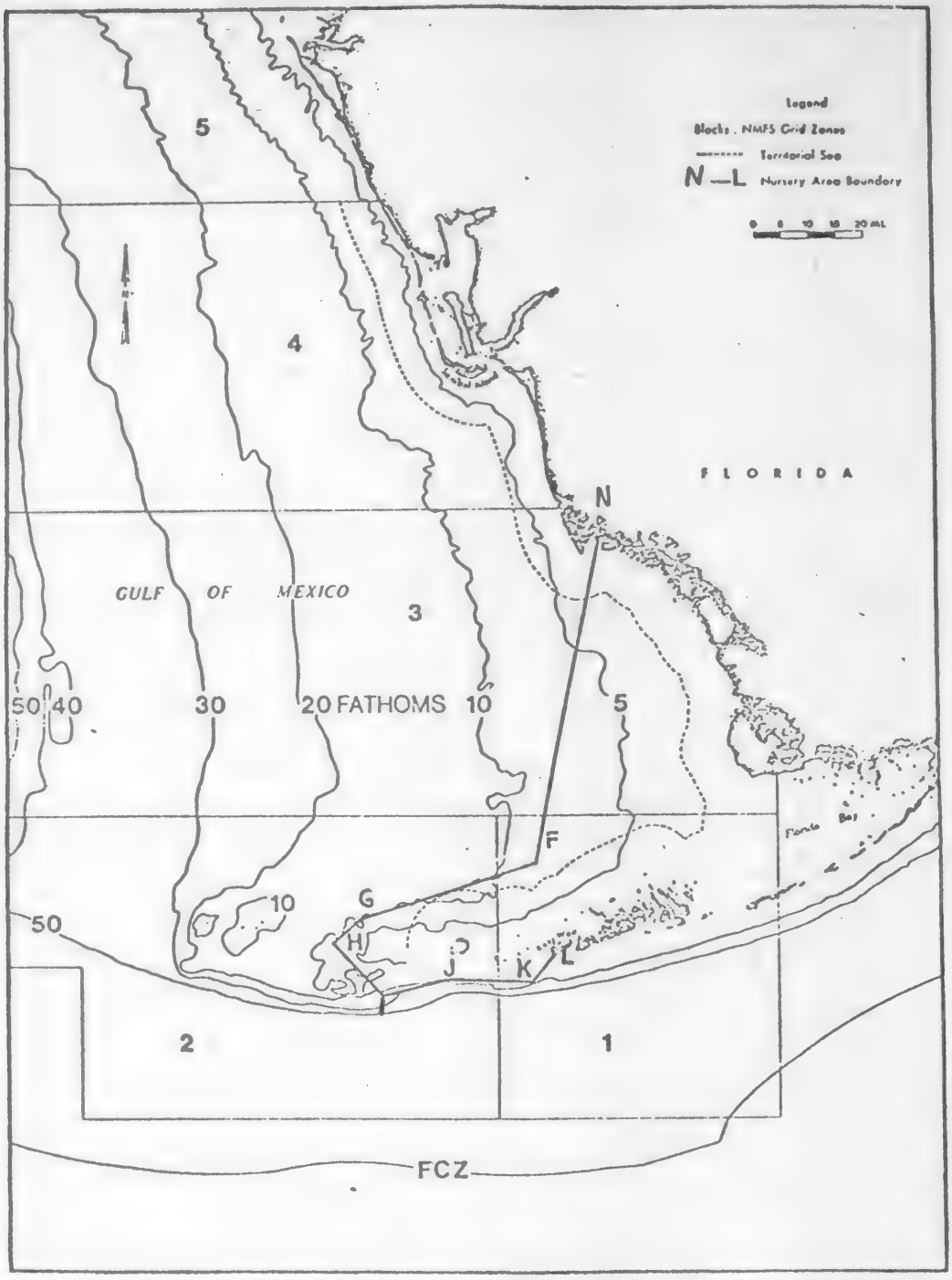


Figure 8.3-1. Location of proposed Tortugas Shrimp Sanctuary. See Table 8.3-2 for definition of line N -L.

BILLING CODE 3510-22-C

Table 8.3–2.—*Expected Average Weight of Male and Female Pink Shrimp in the Dry Tortugas Area as a Function of Depth* [1]

Depth	Males (heads-on)	Females (heads-on)	Count [2] of a 1:1 mixture males to females
fm	g	g	tails per pound
7	[illegible]	[illegible]	[illegible]
8	7.1	10.8	81
9	7.7	11.8	74
10	8.3	12.9	[illegible]
11	[illegible]	14.0	[illegible]
12	[illegible]	15.2	58
13	10.3	16.5	[illegible]
14	11.1	17.8	50
15	11.9	19.3	[illegible]

[1] Expected average weight was calculated from carapace length-depth relationships derived by Iverson et al. (1960) (See Eq. 4.1–1, 4.1–2) and the carapace length-weight relationships of McCoy (1972) (See Table 4.1–3). The formulas used are: Males: $W=0.00148\ (16.394+0.618\ D)\ 2.77$; Females: $W=0.00209\ (17.914+0.868\ D)\ 2.66$. Where W is weight of shrimp in grams and D is depth in fathoms.

[2] Currently the minimum legal size in Florida is 70 tails to the pound which cannot exceed five percent of the catch. The Table estimates that at a given depth the entire catch will average a given count. It does not denote the depth at which the minimum legal size mix currently in effect in Florida will occur.

Florida law presently prohibits all shrimping (except for live bait fishing under permit) in its nine-mile territorial sea within the sanctuary (Figure 8.3–1). Florida also prohibits Florida vessels from shrimping in the sanctuary beyond its territorial sea. Thus, the vessels which would be displaced by this measure would be non-Florida vessels now fishing the sanctuary beyond the territorial sea and Florida vessels that may be fishing in the area contrary to state law. No estimates on the number of these vessels is available.

A 40 to 50 percent increase in value (Elomo, 1979) and a greater yield of shrimp taken at a larger size will offset any increase in operating expenses for the additional distance that non-Florida vessels may be required to travel from the outer limit of the territorial sea to the sanctuary boundary. Because no minimum size limit is proposed, the elimination of forced discarding will further increase the fishermen's shrimp landings.

No special provision is made for live bait shrimping in the sanctuary in the FCZ because none is presently conducted there. It is limited to the nearshore waters of the territorial sea.

No allocation or redistribution among user groups is expected to result from this action.

Although the Dry Totugas shrimp nursery area has been defined by the best available data, at times pink shrimp smaller than the size preferred for local harvest may be taken beyond the closed area. Similarly, large shrimp may also be found within the nursery area. The present delineation provides for the best conservation and use of the resource according to known information, but the Council recognizes the need for better data and recommends a program of sampling in order to identify more precisely the actual range of small shrimp in this area. When the area can be better defined, it can be adjusted accordingly.

The best available data indicate that as a result of this measure, total shrimp landings would increase by one million pounds. In addition, the average size of shrimp landed would increase, thus increasing the per unit value of the increase in landings as well as the protein yield of the managed fishery. The total exvessel value of the increased landings would increase by $2.29 million, using a price of $2.29 per pound (June, 1978, Eastern Gulf ports). With approximately 900 vessels fishing in this area in 1975, the average increase in revenue per vessel would be $2,544. Employment in the processing sector would increase slightly.

Measure 2: Establish a cooperative closure of the Territorial Sea of Texas and the adjacent U.S. FCZ with the State of Texas and the U.S. Department of Commerce during the time when a substantial portion of the brown shrimp in these waters weigh less than a count of 65 tails to the pound (39) heads-on shrimp to the pound). The U.S. Department of Commerce will close the FCZ, and the time of closing should correspond to the closure by Texas of its territorial sea. Closure normally occurs June 1 to July 15; however, the effects of climatic variation on shrimp growth may necessitate a 15–day flexibility in the closing and opening dates to provide for a closure of no more than 60 days. Provision is to be made to allow taking of royal red shrimp beyond 100 fathoms under permit.

The State of Texas is encouraged to continue the present seasonal closure of its Territorial Sea, to eliminate its count restriction on catch in open water, and to evaluate the effect of its allowing fishing in white shrimp fishery during the closure on brown shrimp.

BILLING CODE 3510-22-M

Table 8.3-3. Possible change in the average weight of the brown and white shrimp if the waters off of Texas are closed to shrimping June and July.

	Yield under present management	Expected weight if fishing is prevented until Aug. 1 and natural mortality is .01	.05	.10	.20
	- - - - - - - - - Million pounds (tails) - - - - - - - - -				
BROWN SHRIMP					
caught and landed	8.3	10.1	8.8	7.5	5.6
Discarded by the brown shrimp fishery	0.0	1.8	1.6	1.3	1.0
Discarded by the white shrimp fishery at 0-5 fathoms off Central Texas	0.0	1.0	0.8	0.6	0.4
TOTAL	8.3	12.9	11.2	9.4	7.0
WHITE SHRIMP					
caught and landed (no growth is assumed)	0.8	0.7	0.6	0.5	0.4
TOTAL WEIGHT	9.1	13.6	11.8	9.9	7.4
NET CHANGE OVER PRESENT HARVEST STRATEGY		+4.5	+2.7	+0.8	-1.7

Table 8.3-4. Possible change in average ex-vessel value of brown and white shrimp if waters off of Texas are closed to shrimping June and July.

	Value under present management	Expected ex-vessel value if fishing is prevented until Aug. 1 and natural mortality is .01	.05	.10	.20
	- - - - - - - - - - - - Million dollars - - - - - - - - -				
BROWN SHRIMP					
caught and landed	17.1	25.6	22.3	18.9	13.9
Discarded by the brown shrimp fishery	0.0	3.4	2.9	2.4	1.8
Discarded by the white shrimp fishery at 0-5 fathoms off Central Texas	0.0	2.1	1.7	1.3	0.7
TOTAL	17.1	31.1	26.9	23.0	16.4
WHITE SHRIMP					
caught and landed (no growth is assumed)	3.0	2.9	2.4	2.0	1.4
TOTAL VALUE	20.1	34.0	29.3	25.0	17.8
NET CHANGE OVER PRESENT HARVEST STRATEGY		+13.9	+9.2	+4.9	-2.3

BILLING CODE 3510-22-C

Rationale: In general, the measure is recommended to increase the yield of shrimp and to eliminate waste by discard of undersized brown shrimp in the FCZ. Data indicate that closure would protect the shrimp until they have generally reached a more valuable size. Elimination of the count restriction would allow all the shrimp that are caught to be landed. A Texas study of the benefits of its white shrimp fishery in the territorial sea seems necessary because of the apparent discard of considerable numbers of small brown shrimp associated with this catch.

The brown shrimp discard off the Texas coast is estimated to average 33 percent by number of the May-through-August catch (Berry and Benton, 1969; Baxter, 1973). The discard apparently occurs not only because of the legal count restriction in Texas but also because price and market favor larger sizes in the Texas area (Baxter, 1973). In Texas there are relatively less landings of smaller-sized shrimp than in Louisiana. There are no shrimp canneries in Texas, and most of the shrimp are processed by freezing. The economy of the industry in the western Gulf is tied to the harvest of shrimp larger than 65 tails to the pound.

Bryan, et al. (1978) found along the central Texas coast that relatively large numbers of small brown shrimp were taken and discarded in waters beyond the state's Territorial Sea out to 20 fathoms during June and July and in the open area inside 4 fathoms during June. They recommended that a seasonal closure of these waters based on biological sampling would protect the brown shrimp until they had reached a useful size for the area's fishery and would eliminate the need for a forced discard of undersized shrimp.

Unpublished data from the Texas Parks and Wildlife Department indicate that shrimp beyond 20 fathoms off the central Texas coast generally are larger than 65 tail count. Because of the variability of distance of the 20 fathom isobath from shore, a zone 30 miles from shore was considered for protection of small brown shrimp. However, only seven percent of the shrimp landed from Gulf waters off Texas in June and July came from beyond 30 miles offshore.

The Council, with support from its Advisory Panel, has made the determination that the entire FCZ off Texas should be closed to increase yield (weight and value), catch per unit of effort, and to facilitate effective law enforcement.

This measure is presently limited to the FCZ off Texas as a *trial measure* which would enhance an existing management regime in the Territorial Sea. It is expected to be immediately beneficial to the majority of present users in the area. The Council, however, recognizes that the seasonal closure could result in displacement and shift of effort in an already highly migratory shrimp fleet. It is the intent of the Council that the biological, ecological, social and economic impact of this measure be monitored so that revisions of the management measure may be made when warranted.

The best available data indicate that shrimp landings would increase 2.1 million pounds after implementation of this measure. This increase includes 0.5 million pounds due to increased shrimp growth and 1.6 million pounds due to utilization of previously discarded shrimp (Table 8.3–3). The ex-vessel value of these increased landings would be $7.1 million, using a price of $2.33 per pound which is an adjusted price due to increased landings of large shrimp. With approximately 1,500 vessels fishing in the area during 1975, the average increase in revenue per vessel would amount to $4,733.

An extension of the closure to offshore Louisiana could have a major impact on the fishery in that area. The measure would not be compatible with present territorial sea management and may have a negative impact on the industry presently geared to the processing of smaller shrimp.

An attempt has been made to assess the possible change in yield associated with this measure. The analysis was based on (1) the reported catch statistics from the area (U.S. Department of Commerce 1970–75); (2) a 25 percent discard rate of brown shrimp by weight (associated with the brown shrimp catch); (3) an expected brown to white shrimp catch ratio of 40:1 in June and 70:1 in July; (4) Parrack's (1978) monomolecular growth rate equations; (5) the July 1978 price structure of shrimp; and (6) four levels of natural mortality. No growth of white shrimp was assumed. Only the brown shrimp discarded in association with the zero-to-four-fathom fishery in central Texas were estimated. Results are summarized in Tables 8.3–3 and 8.3–4 in terms of the average pounds and value of shrimp which could be expected on August 1 if there is no shrimping in the area from June to July and no migration of shrimp out of the area. Both natural and fishing mortality throughout the life cycle of shrimp has been used in estimating mortality. The crude analysis indicates an increase in yield and value when weekly instantaneous natural mortality is in the range of .01 to .10; if natural mortality is in the range of .20, then net losses can be expected.

According to Klima and Parrack (1978), current data on growth and mortality of shrimp populations in the Gulf indicate that maximum weight of unfished populations would occur at "six to nine months of age or at a size of 20–30 shrimp tails per pound." This measure is designed to protect shrimp until they are around 65 tails to the pound. It should increase both yield and value. The Council will monitor the effects of the management regime and reevaluate the need for area closure periodically.

Mark and recapture data available indicate that shrimp exhibit depth migration. It is possible that once the season opens shrimp may generally be about five fathoms deeper and further south along the Texas coast than previously. However, nothing definitive can be suggested (see Section 4.1, Migration).

The measure is expected to have little or no impact on smaller vessels, those 47 feet or less in length. Vessels less than 42 feet fish primarily in the inshore waters which are included in Texas' present closure of the Territorial Sea. Those vessels 42 to 47 feet in length would still find good concentrations of shrimp shoreward of 20 fathoms, their outer range, when the season opens in July according to Bryan, et al. (1978).

The closure will affect other areas by causing a dislocation of effort. Some vessels will tie up, but others will likely fish off other states such as Louisiana, as many do now.

The Gulf shrimp fleet is presently migratory. In 1978, Louisiana sold over 2,300 non-resident shrimp trawl/vessel licenses even though many of the larger Texas vessels will not fish within Louisiana's Territorial Sea or land in Louisiana.

In 1976, about 20 percent of the volume and 25 percent of the value of Louisiana's Gulf shrimp catch was landed in Texas. (Gulf Coast Shrimp Data).

The Texas-based fleet capable of fishing in the FCZ consists of approximately 1,000 vessels. Another 500 vessels from other states, including Louisiana, fish off Texas during a portion of the year. (Texas Parks and Wildlife Department license records.)

In determining that the closure should extend through the entire FCZ off the Texas coast the Council made the following determinations in conformance with the National Standards:

1. Management Objectives 1 and 3 will be met by increasing the opportunity for greater yield in product

and value and by enhancing the existing management regime of the adjacent state. In this trial measure the brown shrimp stock will be managed in its range from the estuary and territorial sea through the FCZ.

2. There will be no discrimination against any group by this measure. All vessels will have the same opportunity to catch the larger, more valuable shrimp during open season. Small boats restricted to near-shore operation are already excluded from fishing during this period by the nine-mile Texas territorial sea closure and may resume fishing when the season reopens for all boats and vessels. No allocation is made among fishermen.

3. The low yield of large shrimp offshore and beyond 20 fathoms during this period does not provide for an efficient fishery according to the advisory panel and landing statistics.

4. Enforcement difficulties presently encountered by the state with vessels moving from the FCZ to the closed territorial sea would be greatly reduced. Closure of the FCZ to 200 miles would prevent a similar enforcement problem in the FCZ.

5. The measure takes into account the variation in the brown shrimp fishery in Texas directed toward a larger size product.

6. The measure would minimize costs by enhancing an existing management regime.

7. The measure conforms to best data available from state and other researchers concerning this fishery.

8. Most importantly, this measure is directed toward achieving optimum yield in the fishery while preventing growth overfishing.

9. This measure is parallel with the establishment of the Tortugas Shrimp Sanctuary for pink shrimp. Pink shrimp emigrate from inshore nursery grounds over a long period while brown shrimp move in a major migration in late May or early June.

Measure 3: Recommend that all states consider establishing shrimp management sanctuaries in important segments of nursery grounds under their sole jurisdiction. Within these areas shrimp would be protected from harvest until they have reached an optimum size for harvest by the user groups dependent upon them. In all open areas shrimpers would be allowed to keep all shrimp they harvest—that is, there should be no laws which would force the culling of shrimp caught.

All states are encouraged to continue their monitoring of these areas in order to provide basic data for management—especially data on habitat quality, yield predictions, and variations in the area distribution of shrimp.

Rationale: There are diverse user groups dependent on shrimp of differing sizes in the Gulf area. In fact, the conflict between interest groups is often acute in the states' internal waters. Currently, the Gulf states are attempting to provide accommodation for the various groups dependent upon these resources while protecting shrimp smaller than useful size. This problem will not be easy to solve since the number of recreational and commercial shrimpers is apparently increasing.

The most vulnerable area appears to be shallow water estuaries. These areas, critical for growth and development of brown, white, and pink shrimp, are also fragile ecosystems which are being affected by man (Lindall and Saloman, 1977).

It is conceivable that shrimp within these areas could be harvested and used at an extremely small size, say 300 tails to the pound, particularly by recreationists. In the other hand, basic biological data reviewed in the development of this plan indicate that yield would be maximized if shrimp were harvested at sizes larger than minimum count laws currently enforced in the Gulf area. These viewpoints provide the Gulf states biological flexibility in deciding which size ranges of shrimp would give the best yields.

The respective Gulf states can protect critical habitat areas, reduce the waste of shrimp from culling, and probably increase the yield of shrimp by identifying the areas where shrimp smaller than useful size exist and closing those areas to shrimping on a seasonal or permanent basis. Without such closures it is likely that these areas will be subject to increased fishing effort as competition for the resource intensifies. Increased effort will likely reduce the overall yield of shrimp. This measure is consistent with the groundfish plan and would afford protection to juvenile recreational and commercial fisheries which utilize the same nursery areas as shrimp.

Where feasible, area closures based on biological sampling are preferred to count laws which force discarding of undersized shrimp and directly waste the resources. The effect of such closures might be to shift fishing areas several miles or more to the larger lakes and bays. The Council will work toward a common management regime throughout the area on a state-by-state basis.

8.5.1.2 *Objective 2: Encourage Adequate Habitat Protection Measures*

Measure 4: The Gulf of Mexico Fishery Management Council has established an internal committee to review and assess the status of Gulf fishery habitats, with particular attention to those factors which might further stimulate "the downward trends in quality and quantity of fish habitats." (Atlantic States Marine Fisheries Commission, et al., 1977). The committee interacts where appropriate, with federal and state agencies to insure that adequate consideration is given to possible impacts of the agencies' actions on these renewable resources. The agencies include, but are not limited to, the states' wildlife management agencies, the U.S. Corps of Engineers, the U.S. Fish and Wildlife Service, the National Marine Fisheries Service, the Environmental Protection Agency, and coastal zone management agencies (in those states which have them).

The Council will adopt the policies set forth in the National Plan for Marine Fisheries and the Eastland Fisheries Survey (Atlantic States Marine Fisheries Commission, et al., 1977) regarding habitat protection and pollution control to:

(1) "Reverse the downward trends in quantity and quality of fish habitats by minimizing further losses and degradation of these habitats, restoring and enhancing them where possible, and establishing protected areas where necessary, while recognizing other compatible essential uses of fish habitat areas.

(a) Improve the consideration given to fish habitats in key decision-making processes.

(b) Where possible, mitigate losses of habitats, restore habitats lost or degraded, and develop economically feasible enhancement opportunities.

(c) Establish sanctuaries, reources, or other systems when necessary to protect critical fish habitats and maintain fish production.

(d) Improve the quality and increase the dissemination of information required for effective fish habitat conservation.

(2) Prevent rapid development of coastal and marine areas including those of the Continental Shelf, where development is based on hastily gathered and often critically incomplete data.

(3) Take stronger action to insure abatement and control of pollution that contaminates fish or adversely influences fish environment and prevent development of new environmental degradation or fish contamination."

Rationale: Man's alteration of the Gulf estuarine and offshore fish habitats appear to pose the greatest threat to viability of fish resources. This is especially true for estuarine areas, since about 90 percent of the commercial and 70 percent of the recreational catches are estuarine-dependent (Lindall and Saloman, 1971). The shrimp fishery depends on acreage of suitable marsh or estuarine habitat not merely on acreage of inland waters. The Council encourages the Secretary of Commerce to aid in achieving wetland conservation. Quantitative studies are needed both to assess potential impacts on fishery habitats by man-made alterations and to support recommendations for workable alternatives. Some direct action is needed now; a Council committee working with the appropriate state and federal agencies appears to be not only a logical extension of the review and advice role of the Council but also a mechanism to insure adequate consideration of the habitat needs of fishery resources addressed in its fishery management plans. This committee is concerned with fishery habitats in general, because of the similarities in species requirements, and because it is necessary to approach these impacts with a multispecies understanding and to carry out the mandate of FCMA (reducing, where possible, duplication of effort). The committee makes recommendations to the Council as needed.

This measure particularly addresses National Standard Number 3 which requires management of the stock throughout its range. Because authority in the estuaries and marshes lies with the various states, the Council recommends coordinated efforts for habitat protection for the shrimp resource.

8.5.1.3 Objective 3: Coordinate, Where Feasible, the Gulf Shrimp Management Programs

Measure 5: The Gulf states are encouraged to adopt flexible management procedures which would provide regulation by administrative agencies of the shrimp resources in inland waters and territorial seas. These agencies would operate within legislative parameters but would have sufficient flexibility to perform such essential tasks as setting the seasons, based on environmental monitoring.

- The State of Florida is encouraged to consider setting its regulations by general law rather than by special laws of local application and to codify all such laws.
- The State of Louisiana is encouraged to enact laws which would authorize LDWF to regulate shrimping activities in its territorial sea.

Rationale: The yield of the dominant shrimp stocks is related to prevalent environmental conditions during the estuarine phase of growth. This dependency results in yearly variations in the times at which shrimp reach a minimum useful size and begin their offshore emigrations.

In order to increase the yield of shrimp, various minimum useful sizes have been established in the Gulf region. Appropriate state agencies are responsible for monitoring the resource and opening and closing seasons based on evaluations of their monitoring. To accomplish this essential task, the agencies must have sufficient flexibility to be able to establish seasons based on interpretations of current, relevant data. Without this flexibility, shrimp are wasted through culling because statutory seasons open on shrimp smaller than a useful size.

If the Gulf states adopt such flexible management where it does not already occur, wasteful culling of shrimp should be reduced; the opening and closing of seasons will then be based on interpretation of current data on the shrimp populations. This management should not drastically affect present seasons because the flexibility required would not normally adjust the seasons more than a few weeks. Also, programs can be devised to provide shrimpers with suitable lead time. Nor will this management result in a drastic increase in the monitoring responsibilities of the various states, since programs are currently in effect to assess the majority of needed parameters.

Measure 6: The Gulf states are encouraged to adopt reciprocal internal management decisions flexible enough to allow joint management of shrimp with other states and with the Department of Commerce.

Rationale: Shrimp and shrimpers in the Gulf states are not limited by state or federal jurisdictional boundaries. Migrations of these populations from one area to another require coordinated flexible management to better protect the biological basis of the resource, to reduce conflicts among shrimpers and the waste of resources, and to ease enforcement problems.

The usefulness of such interaction was evidenced in the preparation of this management plan. The measures recommended herein are, in large part, results of the interaction of state and federal personnel who suggested and assessed measures to reduce the waste of resources and to enhance the industry's vitality. As is appropriate, the final plan will reflect the open public review of these measures to insure that they are sound, acceptable, and designed to promote conservation of our resources. The continued interaction of the appropriate state agencies with the GMFMC is essential if the shrimp resources in the area are to be harvested at optimum levels.

If management measures were coordinated wherever feasible, the likely result would:

(1) provide a stronger base for protecting the environmental basis of the resource;

(2) reduce waste of shrimp resources through the cooperative protection of shrimp smaller than a minimum size for an area;

(3) reduce conflicts between fishermen by coordinating, where feasible, such regulation measures as opening and closing dates;

(4) ease enforcement problems; and

(5) reduce the cost of management by coordinating the monitoring, enforcement, and environmental assessment programs.

8.5.1.4 Objective 4: Promote Consistency with the Endangered Species Act and Marine Mammals Protection Act

Measure 7: Develop and implement an educational program to inform shrimpers of the current status of sea turtle populations and of proper methods of resuscitation and return to sea of incidentally-captured sea turtles.

Rationale: All of the sea turtles that inhabit the U.S. Gulf of Mexico are listed either as threatened or endangered and must be protected. The shrimp fishermen, therefore, need to be informed of the necessity of following good conservation practices in relation to this species.

Informed shrimpers would be prepared both to take adequate measures in releasing turtles in a viable state and to give reliable information on incidental seas turtle capture.

8.5.1.5 Objective 5: When Appropriate, Minimize the Incidental Capture of Finfish by Shrimpers

Measure 8: Encourage research on and development of shrimping gear in order to reduce the incidental catch without decreasing the overall efficiency of shrimping or excessively increasing the cost of gear. This program would include current efforts on an excluder panel to prevent accidental catch of sea turtles; examination of the feasibility of a net mesh size and configuration that

reduces the harvest of shrimp smaller than a given size; and development of a trawl to reduce incidental capture of finfishes (includes efforts on excluder panel, beam trawl, separator trawl).

Rationale: This option would generally reduce the waste not only of marine resources but also of labor efforts, gear damage, and conflicts with other users. Development and use of an excluder panel would greatly reduce the incidental capture of sea turtles and facilitate compliance with the Endangered Species Act.

A shrimp trawl that is size selective for shrimp would allow protection of undersized shrimp without area closures. Reduction in incidental catch of finfish would reduce waste of these resources and conflicts with the groundfish and reef fish fisheries.

The indirect impact of this option includes the possibility of (1) a reduction in finfish bycatch (usually discarded), (2) increases in predation on shrimp by escaping finfish predators, (3) increased competition for food and shelter between shrimp and escaping finfish which occupy ecological niches similar to those of shrimp, (4) a reduction in the amount of food available to scavengers, (5) a reduction in finfish growth rate through stocks not being thinned out, (6) shrimpers might be able to shrimp in areas not previously used, (7) stimulate the development of fisheries utilizing excaping finfish, and (8) the effect of discarding the bycatch on the fertility of the area may be ascertained. The ecosystems should be monitored to determine the best mix of benefits.

8.5.1.6 Objective.6: Minimize Conflicts between Shrimp and Stone Crab Fishermen

Stone crab traps are placed on the bottom where they are inadvertently destroyed by shrimp trawlers. Trawling for pink shrimp is done at night when buoys are not visible. The loss to the stone crab fishery is estimated to be $80,000 per year (Table 1, Stone Crab EIS).

Measure 9: Consistent with the Stone Crab Management Plan, establish a seasonal closure of a portion of the Dry Tortugas shrimp grounds in order to avoid gear conflicts with stone crab fishermen. The area to be closed is outlined in Table 8.3–5 and is generally shown in Fig. 8.3–2 and 8.3–3. The seasonal opening of this area will not affect the "Tortugas Shrimp Sanctuary."

As a result of adopting this line from the Stone Crab FMP, the seasonal exclusion of shrimp vessels from this inshore area would allow for a longer growth period for these generally smaller shrimp. The increase in pounds of shrimp landed has been estimated at 60 thousand. The increase in value due to growth from delay in harvest has been estimated to be $46.2 thousand.

Rationale: The Stone Crab Fishery Management Plan contained a measure to avoid gear conflicts between shrimpers and stone crab fishermen. The seasonal closure developed in that plan is a reasonable compromise between the requirements of these two groups and is incorporated into the plan in order to provide consistency. However, the seasonal opening of the area outlined in the Stone Crab Management Plan will not affect that area closed as the "Tortugas Shrimp Sanctuary"; this area is closed to provide for conservation of shrimp recruited to the Tortugas and Sanibel shrimping grounds.

8.5.1.7 Objective 7: Minimize Adverse Effects of Underwater Obstructions to Shrimp Trawling

Measure 10: The Gulf of Mexico Fishery Management Council will attemp to reduce, where feasible, the loss of offshore trawlable bottom by establishing within GMFMC, a committee to monitor and review construction of offshore reefs, with attention to the needs of the reef fish and shrimp user groups.

Rationale: In the Gulf shrimp fishery, there is a considerable loss of gear and time associated with trawls becoming entangled on artificial underwater obstructions. The adverse effect of these obstructions must be minimized in a way consistent with other national interests.

Table 8.3–5.—Line denoting area to be seasonally closed to prevent gear conflicts between shrimpers and stone crab fishermen. Start in the Florida Keys at Snipe Point (Point F defined on Chart 11420 as 24°41.9′ N and 81°40.5′ W) proceeding northwesterly to Point E (defined as 24°54.5′ N and 81°50.5′ W) thence northeasterly along a line on a compass bearing of approximately 010° magnetic to Point D (25°09.0′ N and 81°47.6′ W) thence northwesternly along the 8 fathom line on a compass bearing of approximately 344.5° magnetic to Point C (described as 26°0.0′ N and 82°04.0′ W) and thence northeasterly to 6 fathoms along a line on a bearing of approximately 016° magnetic to Point B (26°16.0′ N and 81°58.5′ W) and thence northwesterly along a line on a compass bearing of approximately 311° magnetic to Point A (26°36.4′ N and 82°24.3′ W) and thence east to Captiva Pass (Figure 8.3–2). The specific location of Points A through F are as follows:

Table 8.3–5

Point	Location
A	Lat. 26°36.4 N, long. 82°24.3′ W.
B	Lat. 26°16.0 N, long. 81°58.5′ W.
C	Lat. 26°00.0 N, long. 82°04.0′ W.
D	Lat. 25°09.0 N, long. 81°47.6′ W.
E	Lat. 24°54.5 N, long. 81°50.5′ W.
M	Lat. 24°41.9 N, long. 81°40.5′ W.

BILLING CODE 3510-22-M

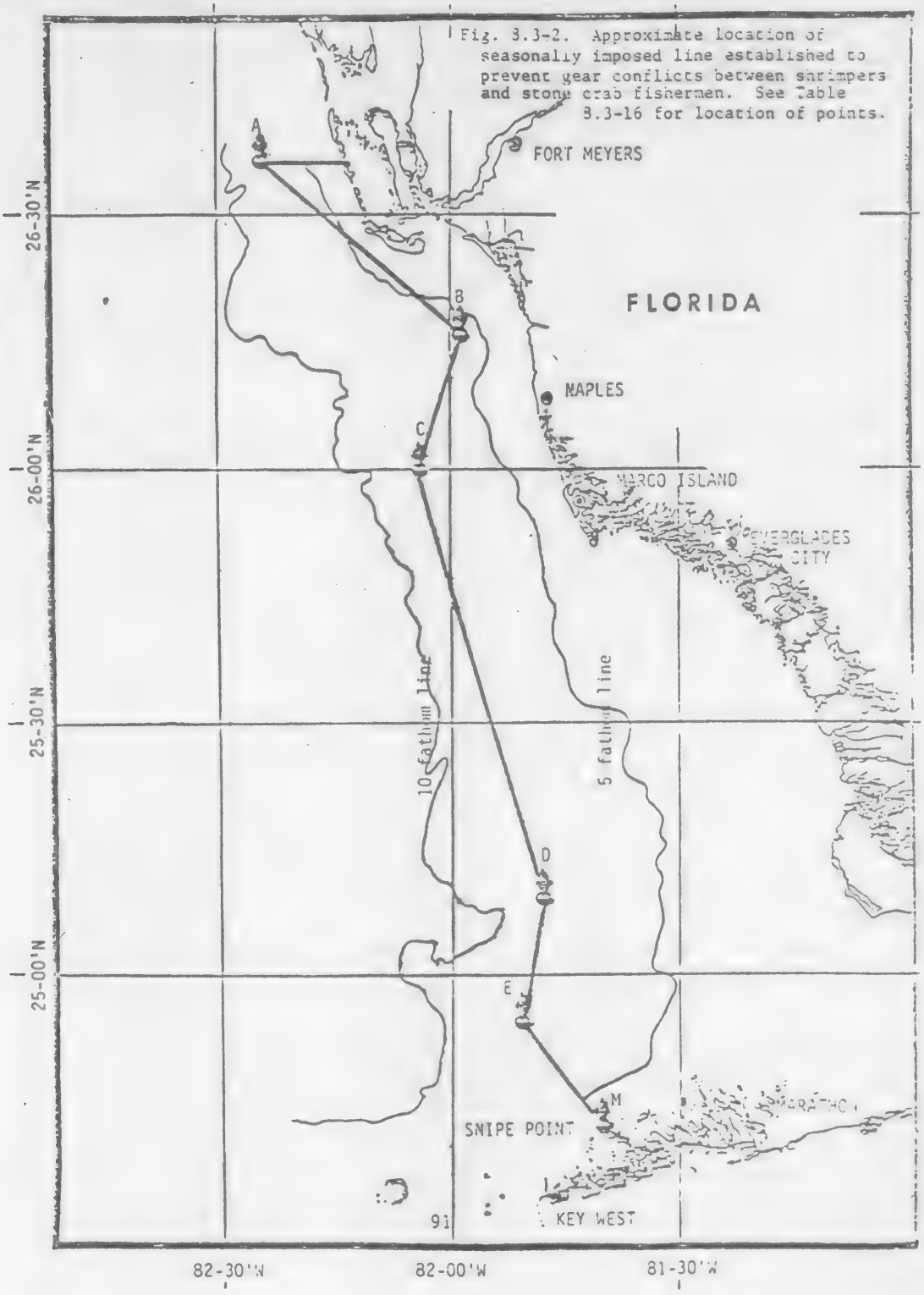


Fig. 3.3-2. Approximate location of seasonally imposed line established to prevent gear conflicts between shrimpers and stone crab fishermen. See Table 3.3-16 for location of points.

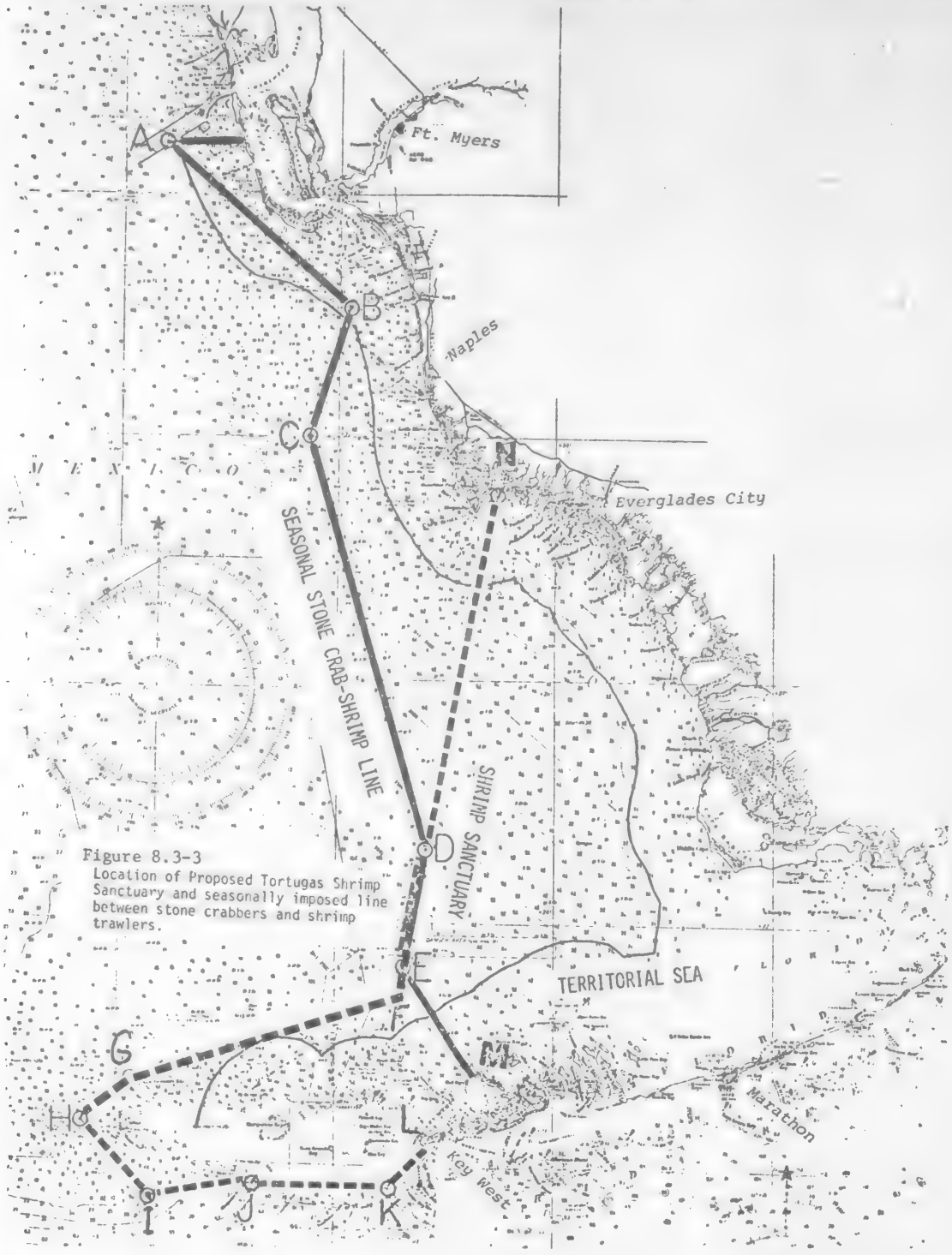


Figure 8.3-3
Location of Proposed Tortugas Shrimp Sanctuary and seasonally imposed line between stone crabbers and shrimp trawlers.

BILLING CODE 3510-22-C

8.5.1.8 Objective 8: Provide for a Statistical Reporting System

Measure 11: All statistical reporting requirements will be mandatory. As a unit, the Gulf shrimp fishery is the most valuable one in the nation. It is also complex and supports a large recreational effort mainly limited to inside state waters, as well as a diverse commercial effort which ranges out to Gulf waters of 200 to 300 fathoms. Data useful for wise management of these resources includes the following (however, not all is to be included in the statistical reporting program):

A. Harvesting sector—all harvestors, recreational and commercial

1. Number of fishermen and mailing addresses.

2. Boat or vessel: home port, length of hull, construction of hull, year built, number in crew, type, make and model number of engine, type, size, and number of gear, presence or absence of salt box, and, when developed and deployed, type of excluder panel used (if required).

3. Catch data by boat or vessel including: date left port; date returned to port; date shrimp landed; catch and value by species, size, area, and depth; shrimping time by species area and depth; size distribution of catch including discards; species composition of catch (including discards).

B. Processing sector

Number and locations of processing plants identified by type of product, seasonal production of types and species processed, and number of employees and seasonality of employment.

Because of the high cost of gathering all the data listed in A and B above, the following alternative system is recommended. The NMFS will be responsible for the design for Council review, implementation and management of surveys to obtain the necessary information to manage the fishery including, but not limited to the following guidelines:

Statistical reporting requirements recommended:

1. Maintain at least the existing commercial statistical reporting system with more timely publication.

2. Require the collection of minimum data on catch, effort, biological and socioeconomic information needed to manage this fishery under FCMA.

3. Require mandatory reporting of *all* selected shrimp fishermen and all selected shrimp dealers and processors. Selection of respondents to be made by NMFS.

4. Utilize the vessel enumeration system to identify saltwater shrimp fishermen.

5. The Fisheries Survey Task Force of Southeast Fisheries Center will be responsible for the design, implementation and management of this survey and will spell out details on what is to be collected based on resources provided.

6. Consideration should be given to improvement of the data base on boat catch and the bait harvest in state waters.

Rationale: Basic statistical data are needed in monitoring the fishery in order to insure the viability of the stocks, to evaluate reasonable solutions to conflicts, and to provide for the management of the fishery.

8.5.2 Alternative Management Measures Considered But Not Adopted

8.5.2.1 No Action

The Council has determined in the plan that management of shrimp stocks in the FCZ can provide a higher yield of shrimp in both weight and value. Management measures therefore were developed to provide this optimum yield from the fishery. Taking no action would result in continuing waste from culling and discard of small shrimp, degradation of shrimp habitat, conflicts among users, and inadequate statistics to monitor the fishery. Implementation of management will serve to address and meet the objectives of the plan.

The anticipated benefits and costs from management measures in this plan provide a comparsion with a "no action" alternative. With this FMP, monetary benefits and costs are projected to be:

Management measure	Benefits	Costs
Torugas nursery area	$2,290,000	$385,900
Texas FCZ closed June-July	7,100,000	75,300
Total	9,390,000	461,200

The enforcement costs of the stone crab-shrimp separation line primarily provides a space and time separation between fishermen to prevent unquantifiable conflicts. Without these measures, either the status quo would prevail, as in the case of shrimping in the Texas FCZ, or the Tortugas area would continue to experience a lower total yield than when the traditional nursery area was closed by Florida.

8.5.2.2 Size and/or Season Regulations

1. *Modify Any of the Minimum Size Ranges of White Shrimp Seasonally Imposed by the Gulf States and/or Establish Minimum Size Ranges for White Shrimp in the FCZ.*—Minimum size limits require culling and discarding of small shrimp, a wasteful and self-defeating practice. The purpose, to direct fishing effort toward larger, more valuable shrimp, can more constructively be attained. This plan uses closed areas and seasonal closures on small shrimp to accomplish the objective.

No size restrictions are proposed in the FCZ but the management regime selected should encourage harvesting in the FCZ of the optimum weight and value, and the plan encourages states to permit the landing of any size shrimp from open areas.

Because the fishery for white shrimp is inshore, the plan suggests that states identify and close to trawling those areas in their internal waters and territorial seas where shrimp are too small for best local use.

The existing minimum size patterns as currently outlined by the states do not appear to threaten the biological basis of the resource. As the size of shrimp is frequently associated with the area and depth of harvest, the ability of the fleet to harvest the resource would be affected if the minimum size were changed; boats could be dislocated or excluded from the fishery. Additionally, as most states currently impose size regulations based on local industry demands, local processors in the Gulf could be disrupted.

2. *No Size Regulation.*—No size regulation with no area closures to protect undersized shrimp would likely result in a harvest with a wider range of sizes. The mix would consist of more smaller size shrimp and consequently less large shrimp. Because there are few sufficiently developed markets for the smaller ranges of shrimp except in Louisiana, discard could be expected to increase, resulting in greater biological waste. It could also be expected to result in a greater concentration of fishing effort in nearshore and inland waters on juvenile shrimp. This could result in a decreased harvest for deep-water vessels. More shrimp would be harvested, but with less total poundage and lower total value.

3. *Determine Preferred Minimum Size and Regulate Area and Season for That Size. Allow Retention of All Catch Regardless of Size.*—This approach has been proposed in those measures which establish seasonal closures for areas off of Texas and Florida as an extension of present state management schemes, as well as in Option 3, Section 8.3.1.1, where it is suggested that the Gulf states consider such delineations and closures.

The shrimp fishery has a number of processing entities (e.g., fresh, frozen, canned, etc.), each of which contributes

to the economy of the nation, and each of which has preferred sizes. If this alternative were implemented, it would provide protection for the resource until the preferred minimum size for the area were attained thus delaying the harvest. Some processors might be disrupted temporarily due to the loss of fresh shrimp during the time of closure. The congestion of boats and vessels within open waters could increase, intensifying conflicts over trawlable space. The elimination of forced discard would reduce biological and economic waste.

Those shrimpers who have traditionally fished in an area of closure would be displaced. Boats smaller than 47 feet in length would not be entirely displaced as a closure of an area in the FCZ would still permit shrimping within a state's inland and territorial waters. Those using deepwater vessels would move to further fishing grounds that were not within the area of closure with an attendant increase in fuel consumption. The extent of the disclocation would depend on the area closed.

4. *Establish a Minimum Shrimp Count Size in the FCZ, Under Which White Shrimp May Not Be Retained.*—White shrimp which reach the FCZ are large enough to comply with the landing laws of the adjacent area. There is no need to protect undersized white shrimp in the FCZ because recruitment or growth overfishing is not evident there.

The imposition of a minimum size count with a forced discard is unnecesary and would result in increased biological waste due to the culling of shrimp smaller than permitted, if and when they should occur there.

5. *Establish a Cooperative Seasonal Closure to Shrimping in the FCZ off Texas within 20 fathoms in June and July to Protect Undersized Brown Shrimp.*—Currently, the Texas Territorial Sea is usually closed from June 1 through July 15. There is a variable, but often substantial discard of small brown shrimp in the Territorial Sea and FCZ associated with Texas during the May–August period. This closure reduces the biological waste that presently occurs when large quantities of undersized shrimp are discarded.

The extension of the closed season to 20 fathoms in the FCZ was considered because Texas researchers found that small shrimp usually do not extend beyond 20 fathoms. Shrimp of the preferred size do occur beyond that depth off the central Texas coast with infrequent mixing of smaller sizes. The 20 fathom isobath is about 20 miles from shore in the study area but is much closer on the lower Texas coast and more than 50 miles offshore near Louisiana. Size distribution offshore is as much a function of distance as depth. Shrimp fishermen document occasions when small shrimp are taken beyond this depth.

Becaue a meandering depth contour was not practical as a line of closure, various distances from shore were suggested as alternatives.

Closure of only a portion of the FCZ would cause substantial enforcement problems in monitoring the area of limited closure. Because the line of closure is based on a depth delineation, there may result some hardship to fishermen attempting to stay just beyond the 20 fathom range. Texas' present Territorial Sea closure is difficult to enforce because vessels move inshore under cover of darkness when shrimping occurs. The enforcement costs requiring full at-sea patrols were estimated by NMFS to be $202,400.

6. *Establish a Cooperative Seasonal Closure of the Territorial Sea off of Texas and the Associated FCZ within 30 Nautical Miles to Protect Undersized Brown Shrimp.*—This alternative is similar to the previous measure. It is an extension of present Texas management policies. Currently, the Texas Territorial Sea is usually closed from June 1 through July 15. There is a variable, but often substantial discard of brown shrimp in the Territorial Sea and FCZ associated with Texas during the May–August period. This closure would reduce the biological waste that presently occurs when large quantities of undersized shrimp move beyond the state's closure of the Territorial Sea. The 30-mile line was considered to provide a zone beyond which most shrimp would provide an optimum yield in weight and value.

With support from its advisory panel, the Council has determined that a partial closure of the FCZ in this instance would be ineffective. Shrimping is done at night and vessels can move into the closed area to fish. Small shrimp do move far offshore on occasion. Only seven percent of shrimp landed from Gulf waters off Texas during this period came from beyond 30 miles. The alternative of expanding the closure to encompass the entire FCZ associated with Texas was adopted. The enforcement costs requiring full at-sea patrols were estimated by NMFS to be $136,000.

8.5.2.3 Spawning Area Closures

1. *Protect Spawning White Shrimp From Harvest in April Through July.*—Although white shrimp have the shallowest depth range of the three major species and are fished extensively throughout their range, catch-effort data do not indicate a decline as a result of recruitment overfishing. Data also indicate multiple spawning of white shrimp in a season with wide ranging spawning areas which are difficult to delineate.

No scientific data exist to show an advantage from protecting spawning shrimp. There is no relationship between the number of spawners and recruits.

2. *Establish a Trial Sanctuary in April and May in the FCZ South of Mississippi to Protect Spawning White Shrimp and Assess Spawner Recruit Relationship.*—In recent years there has been a decline in the white shrimp fishery off Mississippi and Alabama. Because white shrimp live in the bays, sounds, and inshore Gulf, they are heavily fished throughout their range. Some fishermen have suggested that heavy fishing on spawning adults off Mississippi may be a factor in the decline of stocks in that area. Best available scientific data, however, show no relationship between the number of spawners and subsequent number of recruits to the fishery.

Establishment of a seasonal sanctuary for the spawners would result in the loss of the spring catch in that area with no evidence of justification.

3. *Close the Offshore Waters of the Northern Gulf CFCZ and Territorial Sea to All Shrimping from Approximately April 15 to Approximately June 15 Each Year (At Least East of the Mississippi River).*

4. *Area Closures to Protect Spawning Populations of Brown Shrimp.*

5. *Area Closures to Protect Spawning Populations of Pink Shrimp.*

The same rationale for rejection was established for measures 3, 4, and 5 as for all other proposals for protection of spawning shrimp. There are no scientific data to support a measure to protect spawning shrimp because no relationship between number of spawners and subsequent number of recruits to the fishery has been found.

6. *Area Closures to Protect Spawning Populations of Royal Red, Rock and Seabob.*

Royal reds (off St. Augustine, Florida) are believed to spawn during the winter. Unlike other species of shrimp, they are harvested over several year classes.

The area of spawning for rock shrimp has not been determined as they are not believed to be estuarine dependent.

Seabobs spawn in the Gulf off of Louisiana during July–December. They are not estuarine dependent.

Present data on all three species is incomplete. Rock and seabob shrimp have been harvested mainly as an

incidental bycatch. Spawning area closures would be difficult to identify and might conflict with peak harvesting for the major species, thus restricting shrimpers in those areas so closed, and disrupting local processors. This could be an unnecessary disruption as there is no apparent spawner-recruit relationship.

8.5.2.4 Licensing and Data Collection

1. *A No-Cost Permit Be Issued to "Recreational" Shrimpers (Trawlers Only).*

This measure would permit identification and determination of the effort by recreational shrimpers in the FCZ. Substantial costs would occur in the governmental sector. These costs appear unjustified because most recreational shrimping occurs within inland and nearshore waters. Recreational shrimpers will be identified by a vessel enumeration system through state boat registration.

2. *Numerous Recommendations Were Considered Dealing With the Licensing of Different Types of Trawls.*

Costs of implementing this type of regulation would be substantial to fishermen with no benefits to be derived from such regulation. Identification of users is to be obtained through a vessel enumeration program.

8.5.2.5 Limited Entry and Gear Restrictions

1. *Impose Limited Entry in the FCZ*

Provided there was no increase in effort in the states' waters, the imposition of limited entry in the FCZ would have substantial economic impact. The catch per unit of effort could be expected to increase and provide stable incomes for those permitted to participate in the fishery. There would be reduction in the amount of disturbance to the benthic habitat as well as possible reduction in the incidental capture of associated fisheries. There would be an overall decrease in consumption of fuel within the industry as well as reduced conflicts over space for trawling in the FCZ. Incidental factors such as lack of ice supplies could be expected to improve.

Without a limit on entry in the states' waters, this measure could also be expected to result in intensified effort in waters within state jurisdiction. The increased pressure on juvenile shrimp in these areas may decrease the poundage of yield harvested by deepwater vessels. Additionally, it would be most difficult for people not presently in the fishery in the FCZ to participate, particularly young people. Excessive economic rent may accrue to industry members unless taxed away or controlled by government.

The measure was not recommended because there is insufficient data on who is using the resource, on what the benefits (if any) to society at large would be, and on how methods to limit entry would be made consistent with the mandates of FCMA. A discussion of overcapitalization is presented in Section 3.5.2.3.

2. *Various Limitations on the Width, Mesh, and Type of Trawl*

Regulation of the width, mesh, and type of trawls might reduce disturbance of the benthic habitat, reduce conflicts over trawling space, and reduce the incidental catch of associated fisheries.

As the industry is presently using the most efficient gear economically available, changes rendering current gear useless could result in increased costs to the fishermen as well as the consumer. Additionally, such restrictions could reduce the catch per unit of effort and possibly result in lay-offs in the processing industry. There is evidence that gear restrictions actually increase capitalization and costs (Johnson and Toevs, 1979).

8.5.2.6 Recommend Consideration to Change Endangered Species Act to Permit Incidental Catch and Release of Sea Turtles

Sea turtles protected by the Endangered Species Act may be captured unwittingly. Even though shrimpers may release the turtles unharmed, they are in tehcnical violation of the Act when they capture an endangered turtle. The suggestion was made to recommend that the Act be changed to provide for incidental capture and release of endangered and threatened turtles.

This proposal was rejected as being beyond the authority of the Council's planning responsibility.

8.5.3 Management Measures for Foreign Fishing

Currently there is no foreign fishing for shrimp in the U.S. Gulf of Mexico, nor are there applications for the only stock (royal red shrimp) which has an estimated surplus in 1980 and 1981 for total allowable level of foreign fishing (TALFF). Measures to provide catch data and area/depth restrictions to eliminate nonsurplus bycatch will be specified in the permits or in the regulations as may be appropriate. In addition, the Secretary is requested to place the following three restrictions on any foreign nation fishing for royal red shrimp which were adopted by the Council.

1. Foreign fishing for royal red shrimp is to be accomplished by trawl; however, gear other than standard shrimp trawl may be used after approval by the Secretary after consultation with the Council.

2. Foreign fishing for royal red shrimp is to be permitted only in depths beyond 100 fathoms.

3. Bycatch of foreign vessels fishing for royal red shrimp is to be monitored and the Secretary, after consultation with the Council, may require appropriate conservation measures.

8.5.4 Relationship of Recommended Measures to Existing Laws and Policies

8.5.4.1 Other Fishery Management Plans Prepared by a Council or the Secretary

The plan is consistent with the Stone Crab Management Plan, the Draft Reef Fish Management Plan, and the current status of the Groundfish Plan now being drafted.

8.5.4.2 Federal Laws and Policies

The plan attempts to be consistent with the Endangered Species Act and Marine Mammals Protection Act. Section 7 consultations have been requested from appropriate federal agencies to assure conformance (EIS Appendix B, Exhibits 1 and 2).

8.5.4.3 State Laws and Policies

The following section contains a discussion of the relationship between the shrimp plan and the existing state laws and policies. Where discrepancies are apparent, they are pointed out for consideration by the appropriate state.

Texas Laws and Policies:

Relationship to 8.5.1.1, Measure 2:

The Texas Territorial Sea is closed from June 1 to July 15 to protect small brown shrimp during the major emigration period. Based on sound biological data, the season may be extended to no more than 60 days by the Texas Parks and Wildlife Commission changing the opening or closing dates. Currently, white shrimp within four fathoms may be harvested during the closed season.

If Texas adopted this option it would eliminate its minimum size limit and resulting forced discard of small brown shrimp.

Relationship to 8.5.1.1, Measure 3:

The Texas Parks and Wildlife Department currently has the flexibility to determine opening and closing of the summer season in outside waters. However, the department has no flexibility in determining the time of the

winter closed season. Texas statutes presently impose a size limitation of 65 tails, or 39 heads-on, shrimp to the pound on shrimp caught. Possession of shrimp smaller than the minimum size violates the law.

If Texas decides to manage by closed area or area without size restriction, its statutory scheme might be amended. For example, Sec. 77:062 might be amended to provide the Commission the authority to change the opening and closing of both the summer and winter season (or areas), the decision to be based on sound biological data acquired through sampling. Conceivably the seasons (or areas) could then be opened when shrimp have reached the minimum size desired. Further, Texas might amend both Sec. 77:013, which contains size limitations, and Sec. 77:014, which provides the procedures for enforcing size limits.

A 1979 amendment to the Texas Shrimp Conservation Act provides for some bays to serve as shrimp sanctuaries in which no shrimp trawling is permitted.

Relationship to 8.5.1.3, Measure 5:

The Parks and Wildlife Commission is vested with control of the Texas shrimp fishery and is authorized to establish rules and regulations for the conservation and management of shrimp. At present, the Commission has only minimal flexibility in determining the seasons. Texas might amend the statutes and clearly establish that the Commission has full flexibility to set seasons based on their environmental monitoring.

Relationship to 8.5.1.3, Measure 6:

The Texas statutory scheme provides the Department the authority to negotiate reciprocal agreements with other states. However, agreements are limited to the application in Texas' contiguous zone of another state's shrimping regulations to citizens of that state. The Department also has limited authority to cooperate with the Gulf Council in developing a fishery management program.

Texas might broaden the Department's authority to allow it to enter into any reciprocal agreements necessary to insure coordinated management with other interested states. Additionally, the limitation on the Department's authority to cooperate with the Gulf Council puts the state in a difficult position. Texas might make cooperative management easier by repealing Sec. 79:002, which limits the authority granted in Sec. 79:001.

Relationship to 8.5.1.5, Measure 8:

There is a Special Game and Fish Fund (Sec. 11:031–11:033) available for varied uses approved by the Legislature. Since the Department is authorized to conduct research on the use of trawls, nets, and other devices for taking shrimp, there are funds to carry out this measure if required by the state agency and appropriated by the Legislature.

Relationship to 8.5.1.8, Measure 11:

The Department of Parks and Wildlife is authorized to acquire certain data from all licenses, and dealers purchasing seafood from fishermen for resale are required to report quantity and value of products.

Other measures would have little or no effect on existing Texas law and policies.

Louisiana Laws and Policies:

Relationship to 8.5.1.1, Measure 3:

Louisiana has designated certain areas as "sanctuaries," closed to most forms of shrimping (R.S. 56:801); these areas, however, are limited in scope. If Louisiana adopts the sanctuary concept (Management Measure No. 3), legislative action would be needed to implement this provision: the Louisiana legislature might amend R.S. 56:493, authorizing the Department of Wildlife and Fisheries to designate areas as needed, or it could create sanctuary areas by special provision. (It is noteworthy that, during 1975, a series of public hearings on the feasibility of establishing additional sanctuaries was held throughout the state. A renewal of these efforts appears justified.)

Louisiana's present management procedures divide the waters in which shrimp are found into inside and outside waters. Because of the indefinite nature of Louisiana's water/land interface, the definitions are quite precise, and the statute draws the line delineating these waters. If a sanctuary area is designated, Louisiana might create these divisions: the sanctuary waters, inside waters (which would refer to open bays), and outside waters as already defined. The exact delineation of the sanctuary areas may be difficult and perhaps likely to result in legal challenges and enforcement problems. The state might grant this authority to the LDWF by amending R.S. 56:495 to provide for the designation of the protected areas in the same manner that inside and outside waters are determined; however, it may be more feasible to permit LDWF to open and close areas as appropriate (R.S. 56:497).

Relationship to 8.5.1.3, Measure 5:

The Wildlife and Fisheries Commission does not have exclusive control of the shrimp fishery or shrimp industry. Although the Commission is authorized to open or close seasons occasionally at times other than the regular seasons and may set special seasons for all or part of the inside waters, the two major seasons are set by statute. These seasons apply only to inside waters and are determined by sampling data; the Commission has only minimal flexibility in setting the spring season and none in setting the fall season.

To provide the flexibility necessary for the best yield, Louisiana might amend R.S. 56:497, giving the Commission the authority to establish open and closed seasons within both inside and outside waters. These seasons should be determined on the basis of biological data acquired through sampling, such as are currently used to determine the opening of the spring season.

Relationship to 8.5.1.3, Measure 6:

The Department of Wildlife and Fisheries is authorized to enter into reciprocal agreements with Mississippi and Texas for the protection of aquatic life found within common waters. While this provides part of the framework for reciprocal agreements, Louisiana might consider legislation authorizing the Department of Wildlife and Fisheries to enter into appropriate agreements with Alabama, Florida, and the Gulf Council, as well as with Texas and Mississippi.

Relationship to 8.5.1.5, Measure 8:

Louisiana currently has sufficient authority to implement this measure and does in fact conduct such research.

Relationship to 8.5.1.8, Measure 11:

The Department of Wildlife and Fisheries is authorized to acquire certain data from commercial shrimpers and processors, but enforcement is limited. Louisiana has no provisions for collecting data from recreational shrimpers.

Other measures would have little or no effect on Louisiana's existing laws and policies.

Mississippi Laws and Policies:

Relationship to 8.5.1.1, Measure 3:

The Mississippi Marine Conservation Commission is authorized to enact all regulations necessary for the "protection, conservation, or propagation of all shrimp. . ." (Sec. 49–15–15 3 k). The Commission has previously enacted ordinances closing

certain areas to shrimping in order to protect juvenile stage shrimp. For example, the Commission has closed to all but bait shrimpers that portion of the state's waters lying one-half mile from the coastline from July 15 to August 15 (Sec. 6100).

If Mississippi adopts the policy, it may have to denote and close other areas or eliminate its count restriction on catch.

Relationship to 8.5.1.3, Measure 5:

Supervision of matters concerning marine aquatic life is vested in the Mississippi Marine Conservation Commission. The Commission has broad authority to adopt and supervise appropriate management plans for marine fisheries. If it adopts the suggestions of the Shrimp Management Plan, the Commission has the mechanism to carry them out.

Relationship to 8.5.1.3, Measure 6:

Mississippi is a member of the Gulf States Marine Fisheries Commission, which was developed to foster cooperation between the states in matters of fish management. The Commission is authorized (49–15–15 j) to enter into agreements with officials of other states for the protection, propagation, and conservation of seafood.

Relationship to 8.5.1.5, Measure 8:

Mississippi has no specific authorization to conduct research on shrimping gear but is authorized to contract the services and facilities of the Gulf Coast Research Laboratory, or of state higher education facilities, for research it deems necessary to foster the seafood industry.

Relationship to 8.5.1.8, Measure 11:

The Commission is authorized to collect limited data from various sources.

Other measures would have little or no effect on Mississippi's existing laws and policies.

Alabama Laws and Policies:

Relationship to 8.5.1.1, Measure 3:

Alabama closes its season on about April 30 and does not open it again until sampling shows an average shrimp count of 68 or less per pound. Undersized shrimp are supposed to be discarded. If Alabama adopts this measure, current laws might be amended to allow possession of all shrimp caught in open areas.

Alabama already designates certain sanctuary areas as closed to shrimping for any purpose (Sec. 9–12–48). Supplemental legislation might be needed to the extent that Alabama finds the sanctuaries inadequate for producing the best yield.

Relationship to 8.5.1.3, Measure 5:

The Division of Marine Resources, under the Department of Conservation and Natural Resources, has been established to develop and administer management schemes for conservation and use of seafoods. It presently has fairly wide latitude in carrying out its programs and could adapt these programs to suggested guidelines if the Division so desired.

Relationship to 8.5.1.3, Measure 6:

Alabama is member of the Gulf States Marine Fisheries Commission which was designed to promote this type of cooperation. The Commissioner of Conservation and Natural Resources is authorized by Sec. 9–12–160 to enter into agreement of reciprocity with other states for the taking of seafood.

Relationship to 8.5.1.5, Measure 8:

Alabama has no specific authorization for the study and development of improved shrimping gear. However, the state has established a Seafoods Fund (9–2–87), which can be used by the Commissioner of Conservation and Natural Resources (9–2–89) in any way deemed appropriate for the benefit of the seafood industry. The governor's approval is necessary for such expenditures.

Relationship to 8.5.1.8, Measure 11:

The Department of Conservation and Natural Resources is authorized to acquire certain data within the realm of commercial seafood production, but enforcement is limited. Alabama has no provisions for collecting data from recreational shrimpers.

Other measures would have little or no effect on Alabama's existing laws and policies.

Florida Laws and Policies:

Relationship to 8.5.1.1, Measure 1:

Closure of the portion of the Tortugas Shrimp Sanctuary in the FCZ will, in large part, reimplement what Florida has done in the past. As noted previously, part of the Tortugas area was reopened to shrimping as a result of a U.S. Supreme Court decision delimiting Florida's Submerged Lands Act jurisdiction. While under Skiriortes, Florida law was still applicable in those waters beyond state waters but had no jurisdiction in the area over out-of-state fishermen.

The Supreme Court decision led to a heated controversy between shrimp fishermen and stone crabbers, because shrimpers began moving into areas of the Tortugas from which they had been excluded under previous law. Enactment of this recommendation by the Council would decrease conflicts between the shrimpers and crabbers.

However, the elimination of a size limit and resulting forced discard of shrimp in the FCZ may cause problems at Florida ports. Problems would be avoided if Florida eliminates its size limit law.

Relationship to 8.5.1.1, Measure 3:

In Florida, it is unlawful to possess a catch with more than five percent "small shrimp"—that is, those smaller than 47 with heads or 70 without heads. Florida's law implicitly requires fishermen to discard small shrimp in excess of the five percent allowed by law. In this respect it differs from the proposal.

If Florida adopts the objective, its legislature might amend the shrimp count law so that count is only used to determine when the season (or area) is opened. Once the season (or area) is opened, Florida might then allow a shrimper to keep his entire catch rather than having to cull out the small ones. To protect undersized shrimp, Florida may find it necessary to delineate sanctuary areas.

Relationship to 8.5.1.3, Measure 5:

There is presently some flexibility in the administration of fisheries in Florida. The Division of Marine Resources within the Department of Natural Resources apparently has authority to open and close areas (based on biological data), but the authority has not been exercised to the fullest extent. The Florida legislature might consider the enactment of a clearly written statute authorizing the Division of Marine Resources to use biological data in opening and closing areas to shrimping during the year.

Relationship to 8.5.1.3, Measure 6:

Florida has a reciprocal agreement with Alabama concerning access to shrimping waters. However, there have been no agreements adopted that would provide for joint management, and it is questionable whether the Department of Natural Resources has statutory authority to make such an agreement. If Florida adopts the option, its legislature might provide the Department with this authority.

Relationship to 8.5.1.5, Measure 8:

Florida's Department of Natural Resources presently has authority to regulate "the method, manner, and equipment used in the taking of shrimp," but there is no indication that ongoing

research to develop gear is being conducted.

Relationship to 8.5.1.6, Measure 9:

If Florida adopts seasonal closure of a portion of the Dry Tortugas Shrimp Grounds, it will require legislative action. Presently, Sec. 370.151 closes an area designated as the Tortugas Shrimp Bed. Florida might find it useful to amend this law so that it also differentiates the seasonal closure of a delineated portion of the Dry Tortugas Shrimp Ground. Alternatively, the Division of Marine Resources is authorized by Sec. 370.15 to control the method, manner, and equipment used in the taking of shrimp, as well as limiting and defining the areas where shrimp can be taken. There appears to be sufficient authority to regulate a seasonal closure of the Tortugas Shrimp Grounds, which could be accomplished with a specific subsection for this area.

Relationship to 8.5.1.8, Measure 11:

Florida has legislation authorizing the acquisition of the various data listed in the recommendation, but the provision is not enforced.

Other measures would have little or no effect on Florida's existing laws and policies.

8.6 Enforcement Requirements

Enforcement agents of NMFS will be required.

Coast Guard aircraft and patrol vessels are needed for patrol.

8.7 Cooperative Research Requirements

Data needs in the fishery have been identified by the interdisciplinary team which prepared Christmas and Etzold (1977).

These data are also needed under FCMA and are therefore adopted here. However, priorities may differ; for example, adequate socioeconomic data are critically needed.

8.8 Permit Requirements

No permits are required except as may be required of foreign vessels.

8.9 Financing Requirements

8.9.1 Management and Enforcement Costs

8.9.1.1 Tortugas Closure (year round) Measure No. 1:

Estimated vessel population = 1,000
50 percent at-sea enforcement mode
Patrol days required = 83
Cost of patrol days = $232,400
Aircraft hours required = 83
Cost of aircraft hours = $83,000
Enforcement officers required = 1.4
Cost of officers = $35,000
Subtotal—Tortugas closure = $350,400

8.9.1.2 Texas Closure (45 days) Measure No. 2:

Estimated vessel population = 1,500
50 percent at-sea enforcement mode
Patrol days required = 125 (annual)
Forty-five day patrol requirement = 16
Cost of patrol days = $44,800
Aircraft hours required = 16
Cost of aircraft hours = $16,000
Enforcement officers required = 0.3
Cost of officers = $7,500
Subtotal—Texas closure = $68,300

8.9.1.3 Shore-side enforcement for inspections relative to mandatory reporting, etc., Measure No. 11:

Estimated vessel population = 4,000
50 percent shore-side enforcement
Inspection days required = 667
Inspectors required = 3.0
Cost of Inspectors = $75,000

8.9.1.4 Investigations to support sea and shore enforcement:

Total sea and shore staff required = 4.7
Investigators figured at 30 percent of (a) above
Agents required = 1.4
Cost of agents = $35,000

8.9.1.5 Support for all enforcement efforts:

Total sea, shore and investigative = 6.1
Support figured at 10 percent of (a) above
Support staff required = 0.6
Cost of support = $15,000

8.9.1.6 Total staff years of effort required and total cost of vessel and aircraft patrols, inspections, investigations and support:

Staff years required = 6.7
Total cost = $543,700

8.9.2 Expected State and Federal Revenues, Taxes, and Fees

No changes in existing revenues are expected other than those which would be required to obtain basic catch-effort data to manage the stocks.

9.0 Statement of Council Intention to Review The Plan After Approval by The Secretary

It is the intention of the Gulf of Mexico Fishery Management Council to monitor and review the plan and implementing regulations on a continuing basis, after its approval by the Secretary. The Council intends that the Secretary of Commerce, after consultation with the Council, develop annual estimates of MSY, DAH, DAP, OY and TALFF using the methodology developed by the Council and specified in Section 4.7. The Secretary will develop the data necessary to derive the specifications according to the equations(s) in the plan. The Secretary will publish the yearly figures as a notice for public review. The Council will monitor the management regime closely to assure that it attains the desired objectives of the management plan.

10.0 Selected Bibliography

The bibliography consists of 268 selected references. A copy is available from the Gulf of Mexico Fishery Management Council.

[FR Doc. 80-34241 Filed 11-6-80; 8:45 am]
BILLING CODE 3510-22-M